City of Sandpoint
Wastewater Treatment Plant

Operation & Maintenance Manual

Volume I

January 2011

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City of Sandpoint Wastewater Treatment Plant Bonner County, Idaho

Operation and Maintenance Manual

January 2011

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STATE OF IDAHO
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Abbreviations

AC	asbestos cement
BOD	Biochemical Oxygen Demand
cf (CF)	cubic feet
cfs	cubic feet per second
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
ESA	Endangered Species Act
fpm	feet per minute
fps	feet per second
ft	feet
gpcd	gallons per capita day
gpm	gallons per minute
Hp	horsepower
HRT	Hydraulic Residence Time
kW	Kilowatt
kwh	kilowatt hour
lb/day	pounds per day
mA	milliamp
MCRT	mean cell residence time; same as SRT
mg/L	milligrams per liter; same as ppm
Mgal	million gallons
mgd	million gallons per day
mL	milliliter
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
MSL (msl)	Mean Sea Level
NPDES	National Pollutant Discharge Elimination System
O_2	oxygen
OSHA	Occupational Safety and Health Administration
PLC	Programmable Logic Controller
ppb	parts per billion; same as µg/L
ppd	pounds per day
ppm	parts per million; same as µg/L
PVC	Polyvinyl Chloride
RAS	Return Activated Sludge
SCADA	Supervisory Control and Data Acquisition (software for integrating components and monitoring operations)
sf (SF)	square feet
SO_2	sulfur dioxide
SRT	Sludge Retention Time; same as MCRT
TDH	Total Dynamic Head
TKN	Total Kjeldahl Nitrogen
TSS	Total Suspended Solids
VFD	Variable Frequency Drive
VOC	Volatile Organic Compounds
VSS	Volatile Suspended Solids
WAS	Waste Activated Sludge
WL	Water Level
WWTP	Wastewater Treatment Plant

Chapter 1

Introduction

Chapter 1 – Introduction

1.1 General

This manual is a guide for operation and management of the Sandpoint Wastewater Treatment Plant (WWTP). The intention of this manual is to provide an on-the-job reference for operators and administrative personnel and updates the original Operation and Maintenance (O&M) Manual (1973 and 1982). The manual does not provide an in-depth coverage of wastewater treatment principles, but assumes that the reader already has a working knowledge of wastewater treatment. The manual does provide information necessary for an operator to apply this knowledge to the Sandpoint WWTP.

The Sandpoint WWTP O&M Manual consists of this document and manufacturer's O&M literature, bound separately. This document provides general and detailed descriptions on the operating processes, parameters, and procedures needed for day-to-day plant operations. The manufacturer's O&M literature contains more specific and detailed information about equipment maintenance. Project submittals are available on file at the City for specific design considerations for each operating system and important components.

1.2 Chapter Summary

This volume contains the following chapters and appendices. Volume II, bound separately, includes half-sized record drawings for 2008 WWTP upgrades.

Chapter	Title	Contents
1	INTRODUCTION	Discusses the contents of the O&M Manual and its use; provides a brief history of the facility and responsibilities of WWTP operations and administrative personnel.
2	PERMITS AND STANDARDS	Discusses the requirements for monitoring, testing, recording and reporting, and effluent limitations for the WWTP operations.
3	GENERAL FACILITY DESCRIPTION	Provides a general description of the facility, briefly introducing the reader to the main components of the plant; also provides design criteria for the 2008-2010 upgrades.
4	HEADWORKS	Describes the function, operation, and maintenance of the fine screen, manual bar screen, automatic sampler, stop gates, and flow monitoring equipment.
5	PRIMARY CLARIFICATION AND STORMWATER CLARIFICATION	Describes the function, operation, and maintenance of the primary clarifiers and stormwater clarifier.

Chapter	Title	Contents
6	BIOLOGICAL TREATMENT	Describes the function, operation, process application, and maintenance of the aeration system for biological treatment prior to clarification.
7	SECONDARY CLARIFICATION AND RAS PUMPING	Describes the function, process, and maintenance of the clarifiers and RAS pumping system.
8	DISINFECTION AND OUTFALL SYSTEM	Describes the function, operation, and maintenance of the Gas Chlorine Injection System, Chlorine Contact Chamber, and the Gas Dechlorination Injection System, Contact Basin, and outfall pipe.
9	BIOSOLIDS HANDLING: PRIMARY SLUDGE AND THICKENED SLUDGE PUMPING	Describes the function, operation, and maintenance of the primary and thickened sludge pump station.
10	BIOSOLIDS HANDLING: WAS PUMPING	Describes the function, operation, and maintenance of pumps associated with biosolids handling for return and waste activated sludge.
11	BIOSOLIDS HANDLING: SOLIDS THICKENING	Describes the gravity sludge thickener and rotary screen thickener operations and maintenance.
12	BIOSOLIDS HANDLING: ANAEROBIC DIGESTION	Describes digestion of biosolids for stabilization prior to disposal.
13	BIOSOLIDS HANDLING: DEWATERING AND DISPOSAL	Describes the belt filter press function, operation, and maintenance.
14	PLANT WATER SYSTEMS	Summary of potable and non-potable water systems.
15	DIGESTER GAS PURIFICATION SYSTEM	Describes the function, operation, and maintenance of the Gas Purifier installed to remove corrosive and odorous hydrogen sulfide H_2S from Anaerobic Digester gas for reuse as boiler heating fuel.
16	ELECTRICAL, INSTRUMENTATION, AND CONTROL	Summarizes process descriptions and mode of operation for the WWTP, monitoring instrumentation, operational control systems, PLC operation, and SCADA interface.
17	MAINTENANCE MANAGEMENT	Describes plant and component maintenance and upkeep and provides a general maintenance schedule.

Chapter	Title	Contents
18	LABORATORY MONITORING, SAMPLING, AND RECORD KEEPING	Discusses laboratory procedures, including laboratory sampling, testing, record keeping, and reporting.
19	EMERGENCY OPERATIONS	Outlines facility emergency plans and procedures.
20	SAFETY	Covers safety and accidents, including accident prevention and reporting; includes emergency numbers and a safety equipment list.
21	UTILITIES	List of utilities that serve the Sandpoint WWTP.
Appendix A	NPDES PERMIT	A copy of the current Sandpoint WWTP Pollution Discharge Elimination System Permit (NPDES). The permit sets pollutant discharge limits, maintenance, and reporting conditions that the facility must meet during the permit term.
Appendix B	CONFINED SPACE REQUIREMENTS	A copy of OSHA's confined space requirements.
Appendix C	LOCK-OUT/TAG-OUT PROCEDURES	A copy of OSHA's lock-out/tag-out requirements for maintenance on equipment in which unexpected energization could cause injury to employees.
Appendix D	CONSTRUCTION PHOTOS	A black-white photo log of buried utilities, equipment, and other key elements of construction during the 2008-2010 upgrades. The index can be used to access the photos stored on the photo CD (included).
Appendix E	MSDS SHEETS	Material safety and data sheets for chemicals used at the facility.
Appendix F	RECORD DRAWINGS	Record Drawings are bound separately.

1.3 Facility History and Upgrades

The Sandpoint wastewater system was originally constructed in its present location in the early 1900s with major improvements in 1973 and 1974, 1982, and solids handling improvements in 1983. Upgrades designed in 2007 and constructed in 2008-2010 addressed aging and deteriorating portions of the WWTP. The upgrades also served to improve screening, improve anaerobic digestion, address permit compliance issues, or reduce maintenance problems. The components upgraded in 2008/2010 are as follows:

- Headworks (new fine screening system)
- Headworks (new grit classifier)
- Headworks (stormwater clarifier flow measurement)

- Aeration Basins: Retrofit basin with fine bubble diffusers, dissolved oxygen control loop for automated blower output to reduce energy consumption, replacement of two centrifugal blowers with positive displacement blowers
- Sulfur Dioxide Dechlorination System (new system)
- Replaced primary/transfer pumps (retrofit)
- Solids Thickening (new system)
- Plant Water Systems (new system)
- Instrumentation and Control (new system for portions of the plant)
- Standby Power (modifications to Control and ATS Systems)

1.4 Flow and Waste Load Projections

The following **Table 1-1** summarizes the projected flow and solids load to the WWTP.

Table 1-1 - Projected Design Conditions

Design Parameter	Average Day	Maximum Month	Peak
Design Period Flow (mgd)	3.62	6.09	14.97
BOD_5 (lb/day)	5094	6873	16678
Suspended Solids (lb/day)	3897	5924	18707
Ammonia Nitrogen (lb/day) [a]	604	1524	--

[a] *Estimate based on historical data.*

1.5 Operation and Managerial Responsibility

The Sandpoint WWTP is owned and operated by the City of Sandpoint for the purpose of protecting the health of their residents and neighbors, and for preserving water quality of the Pend Oreille River.

1.5.1 Operations and Maintenance (O&M) Personnel Responsibilities

The WWTP O&M personnel have the following responsibilities:

- Perform all work with SAFETY as the number one priority.
- Learn proper operating procedures and apply them diligently. Thoroughly study this manual, manufacturer's literature, and other reference material and accumulate "hands-on" experience.
- Maintain accurate and current operation and maintenance records.
- Develop and use good judgment in the expenditure of operating funds.
- Advise management of any factors or problems that might adversely affect system operation or maintenance.
- Monitor the system to evaluate performance and compliance with permits.

1.5.2 Management/Owner Responsibilities

The management and owners have the following responsibilities:

- Hire, promote, and train personnel as necessary to maintain compliance with Federal and State Operator Certification Programs.
- Establish a good working relationship with operating personnel, impressing upon them the necessity of efficient plant operation and maintenance and an adequate system of O&M records.
- Provide operational personnel with adequate funds to support proper operation and maintenance of the facility.
- Provide working conditions, tools, and equipment to safely and efficiently operate and maintain the wastewater system.
- Provide adequate and appropriate training opportunities for O&M personnel.
- Keep the lines of communication open with O&M personnel, resulting in O&M personnel keeping management informed about plant performance, needs, and problems.
- Maintain good relations with the public and regulatory agencies.
- Plan for future facility upgrades and implement funding mechanisms.

Chapter 2

Permits and Standards

Chapter 2 – Permits and Standards

2.1 General

The Sandpoint Wastewater Treatment Plant (WWTP) is designed to meet the requirements of its existing NPDES Permit. It is essential that the operator be completely familiar with those requirements regarding effluent limitations, monitoring, testing, and record keeping and reporting. Proper operation of the WWTP will help protect the natural environment and meet the City's NPDES discharge permit. Failure to satisfy the permit conditions may result in fines and/or jail time.

2.2 Discharge Permit

The Sandpoint WWTP currently has a single permit to discharge treated wastewater to the Pend Oreille River by the United States Environmental Protection Agency (EPA) under the National Pollutant Discharge Elimination System (NPDES). The permit is Waste Discharge Permit No. ID-002084-2, which expired January 5, 2007, and is included in **Appendix A.** Although the permit is currently expired, the WWTP will operate under the permit until EPA issues a new permit.

The discharge permit describes in full detail the conditions and requirements imposed upon the operating authority. Permit requirements cover, but are not limited to, the following basic items:

1. Effluent Quality Limitations
2. Monitoring and Reporting
3. Operations and Maintenance
4. Solid Waste Disposal
5. Monitoring and Enforcing Industrial Pre-treatment Requirements
6. Additional Requirements, including bypass/spill procedures, as outlined in the General Conditions of the Permit

The design criteria utilized in establishing the permit are as follows:

Average annual flow (previous 12 months) .... 3.0 mgd

The effluent limitations of primary concern in the day-to-day operation of the facility appear in **Table 2-1**. In addition to the monitoring requirements at the WWTP, the City's discharge permit requires receiving water monitoring requirements listed in **Table 2-2** (Page 6 of the City's discharge permit). In addition to the effluent limitations, the plant must provide removal of 85 percent of BOD_5 and TSS across the plant for average monthly values.

Table 2-1 - Effluent Limitations and Monitoring Requirements for Outfall 001

PARAMETER	EFFLUENT LIMITATIONS			MONITORING REQUIREMENTS		
	Average Monthly Limit	Average Weekly Limit	Daily Maximum Limit	Sample Location	Sample Frequency	Sample Type
Flow, MGD	—	—	—	Influent or Effluent	Continuous	Recording
Temperature, °C	—	—	—	Effluent	1/day	grab
Biological Oxygen Demand (BOD_5)	30 mg/l	45 mg/l	—	Influent and Effluent	3/week	24-hour composite
	750 lb/day	1100 lb/day	—			
Total Suspended Solids (TSS)	30 mg/l	45 mg/l	—	Influent and Effluent	3/week	24-hour composite
	750 lb/day	1100 lb/day	—			
E.coli Bacteria[1]	126/100 ml	—	406/100 ml	Effluent	3/week	grab
Total Residual Clorine[2]	0.45 mg/L	—	1.1 mg/L	Effluent	1/day	grab
Total Ammonia as N	—	—	—	Effluent	1/month	24-hour composite
Nitrate as N, mg/L	—	—	—	Effluent	1/quarter	24-hour composite
Nitrite as N, mg/L	—	—	—	Effluent	1/quarter	24-hour composite
Total Kjeldahl Nitrogen, mg/L	—	—	—	Effluent	1/quarter	24-hour composite
Total Phosphorus as P, mg/l	—	—	—	Effluent	1/quarter	24-hour composite
Dissolved Orthophosphate as P	—	—	—	Effluent	1/quarter	24-hour composite
PARAMETER	Average Monthly Limit	Average Weekly Limit	Daily Maximum Limit	Sample Location	Sample Frequency	Sample Type
Metals[3]	—	—	—	Influent, Effluent, and Sludge	2/year	24-hour composite (sludge-grab)
Whole Effluent Toxicity[4]	—	—	—	Effluent	1/quarter, fourth year of permit	24-hour composite

1. Monthly and weekly averages are geometric means of all samples measured during the respective time period.
2. The chlorine limit is based on a mixing zone which includes twenty-five percent of the critical low flow volume of the Pend Oreille River.
3. See Part II. Pretreatment Program for additional metals testing requirements.
4. See Part I.C. Whole Effluent Toxicity for additional toxicity testing requirements.

Table 2-2 - Sandpoint WWTP Receiving Water Testing Requirements

Parameter	Monitoring Location	Minimum Sampling Frequency	Sampling Type
Total Ammonia as N, mg/L	Upstream of 001 in Pend Oreille River	1/month	Grab
Temperature, ° C	Downstream of 001 in Pend Oreille River	1/month	Grab
pH, s.u.	Downstream of 001 in Pend Oreille River	1/month	Grab
Total Phosphorus, mg/L	Upstream of 001 in Pend Oreille River	1/month	Grab
Hardness (as $CaCO_3$)	Upstream of 001 in Pend Oreille River	1/month	Grab
Orthophosphorus (mg/L)	Upstream of 001 in Pend Oreille River	1/month	Grab
TKN (mg/L)	Upstream of 001 in Pend Oreille River	1/month	Grab
Nitrate as N (mg/L)	Upstream of 001 in Pend Oreille River	1/month	Grab
Nitrite as N (mg/L)	Upstream of 001 in Pend Oreille River	1/month	Grab

The discharge permit specifies a routine reporting schedule for monthly report monitoring on the DMR form (EPA No. 3320-1). Copies of DMRs and all other reports shall be signed and certified per the requirements of Part IV.J. Signatory Requirements, and submitted to the Director, Office of Water and the State agency at the following addresses:

Original to: United States Environmental Protection Agency Region 10
1200 Sixth Avenue, OW-133
Seattle, Washington 98101

Copy to: Idaho Department of Environmental Quality
Coeur d'Alene Regional Office
2100 Ironwood Pkwy
Coeur d'Alene, Idaho 83814

2.3 Non-Compliance and Upset Condition

For non-compliance or upset conditions, reference sections III.G and IV.H of the NPDES Permit for required actions. The permit outlines specific actions required within 24 hours from the time the permittee becomes aware of the circumstance.

2.4 Reporting Procedures for Spill Conditions

The most common event is a spill or overflow in the collection system, although unexpected discharges may occur at the WWTP. All treatment system personnel must be familiar with reporting procedures for spills of raw or inadequately treated wastewater. Prompt reporting ensures spill cleanup, and expedites monitoring assistance dispatch minimizing health hazards and environmental damage.

To encourage and facilitate prompt reporting, a wall poster showing information to assist operational personnel in reporting any emergency should be posted in the Control Building. The poster should include agencies to contact with names and numbers listed. As a minimum, contact John Tindall with IDEQ at (208)769-1422. An example wall poster is included on **Figure 2-1**.

Permit requirements for bypass/spill procedures and reporting requirements appear in the permit shown in **Appendix A**.

2.5 Future Discharge Conditions

The future NPDES Discharge Permit requirements are unknown at this time. TMDLs on the Pend Oreille River and other downstream water bodies may affect nitrogen, ammonia, and phosphorus discharge limits in the future. Implementation of different operating procedures or processes may be necessary if changes to the current discharge permit occur upon issuance of a revised permit.

Figure 2-1 – Accidental Spill Procedures

IN CASE OF SPILLS OF RAW OR INADEQUATELY TREATED MUNICIPAL WASTEWATER.

STEP 1: During the time a sewage release is occurring, every attempt must be made to pump the sewage or bypass around the leak. Sewage must not be allowed to percolate into the ground or run into surface waters.

STEP 2: Contact John Tindall at the Idaho Department of Environmental Quality (IDEQ): (208)769-1422. Provide as much as possible of the following information:

- Name of facility
- Time/date spill started
- Provisions for chlorination
- Conditions surrounding spill
- Abatement actions
- Assistance required
- Surface water sampling plan (if applicable)

If a major spill occurs during non-working hours or on weekends, the State Communications Office (Emergency Response) should be notified at (800)632-8000, and a local IDEQ representative will be contacted.

STEP 3: The Panhandle Health District should also be contacted for advice on properly handling the public health problems caused by the sewage release. Their number is (208)263-5759. EPA Region X in Seattle should also be contacted if there is any sewage release to surface waters. The number is (206)553-1846 (answering machine for reporting any NPDES non-compliance events).

STEP 4: The need for public information is an issue to discuss with the IDEQ or Panhandle Health District representative when they are contacted. Contact with sewage is a serious potential public health hazard. The public must be protected through controlling access around any contaminated areas and disinfecting contaminated areas. Powdered lime is probably the most effective disinfectant for sewage on the ground, but lime has a high pH and the public should not be allowed in areas where lime has been spread for a few days. Removal of the contaminated soil is the quickest way to prevent public contact. Releases to surface waters can require the notification of the public about the contamination and water quality sampling for bacteria concentrations.

STEP 5: After the spill is cleaned up and the problem corrected, a letter must be sent to IDEQ providing the details on the incident. The letter should include when the release started, how much sewage was spilled, how contaminated soil was handled, how sewage was handled during the spill, how the problem was corrected, and when the problem was corrected. There should also be a discussion on how this type of problem will be prevented in the future.

ADDITIONAL EMERGENCY CONTACTS	TELEPHONE NUMBER
City of Sandpoint	
Public Works Office	208-263-3407
Wastewater Treatment Plant	208-263-3433
Maintenance Shop	208-263-3428
Police	208-263-3105
Water	208-263-3440
Police (Bonner County Sheriff)	208-263-8417
Ambulance	911
Fire Department	208-263-3502
Avista Utilities	
Buried/Overhead Power	800-824-9763 ext. 6951
Natural Gas	800-824-9763 ext. 6951
Idaho Department of Environmental Quality	
John Tindall, P.E.	208-769-1422
Panhandle Health District	208-263-5159
Frontier (telephone)	1-800-483-5000
One Call	811

Chapter 3

General Facility Description

Chapter 3 – General Facility Description

3.1 Introduction

Wastewater treatment at the Sandpoint WWTP involves a number of interrelated components. A process schematic with primary flow paths, estimated hydraulic profile, and design criteria is included to illustrate the interdependence and typical treatment path. This chapter divides the facility into major components and gives a brief general description of each.

3.2 Treatment Process

The purpose of the Sandpoint WWTP is to treat raw wastewater from residential, commercial, and industrial sources to a standard that allows discharge into the Pend Oreille River. The treatment process originally used and modified during the 2008-2010 upgrades is a biological process utilizing an aeration basin for aerobic treatment. A flow schematic of the treatment process, estimated hydraulic grade line through the facility, and design criteria for the 2008-2010 upgrades is shown on **Figure 3-1, Figure 3-2,** and **Figure 3-3**, respectively. As shown on the figures, the process chain is as follows:

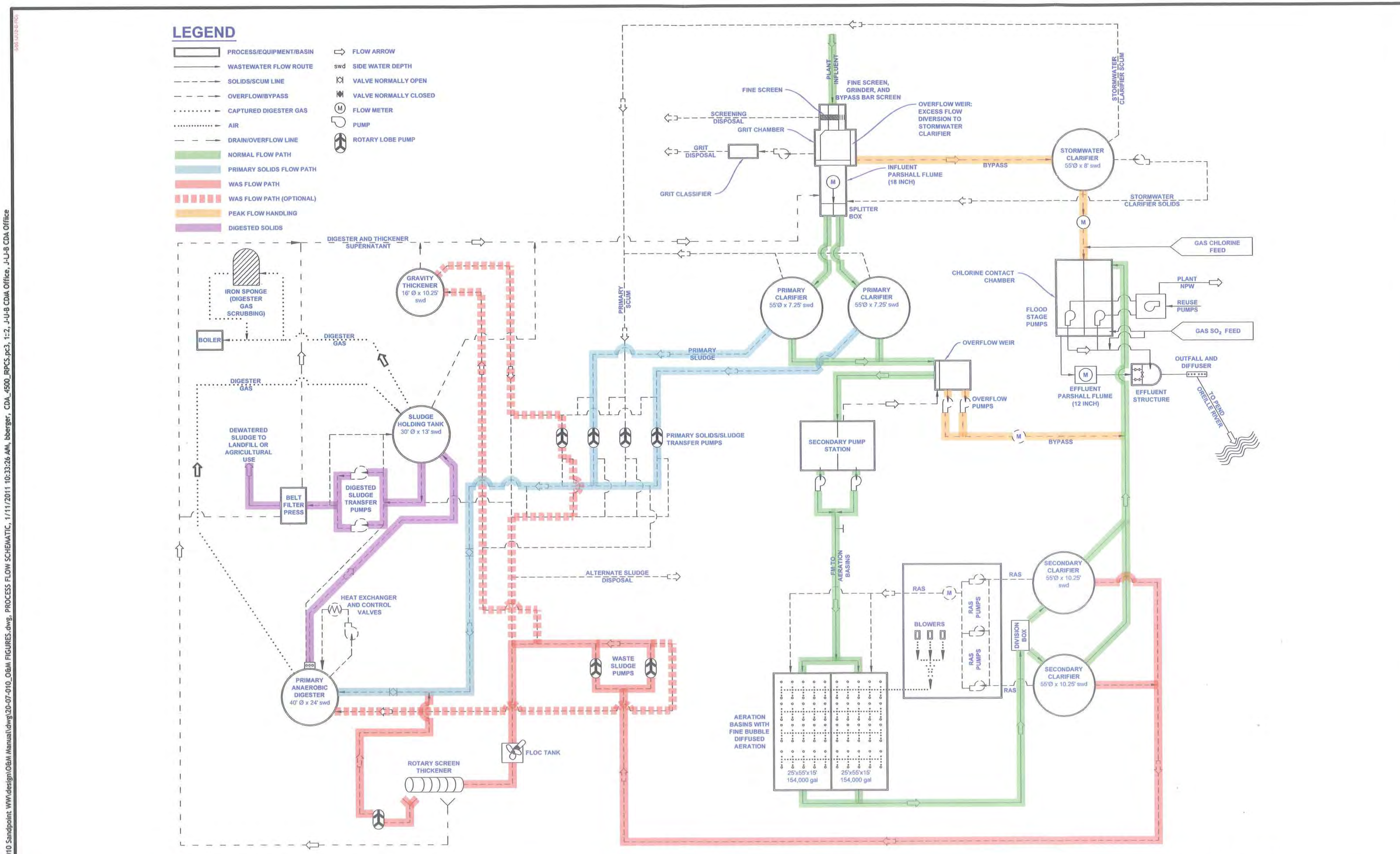
- Headworks (Influent Fine Screening, Grit Removal, and Influent Flow Measurement)
- Primary Clarification, Stormwater Clarifier, and Pumping System
- Secondary pump station
- Aerobic treatment in the Aeration Basins
- Secondary Clarification and RAS Pumping (no modifications)
- Disinfection System and Chlorine Contact Chamber (Chlorination and Dechlorination)
- Effluent Flow Measurement and discharge to the Pend Oreille River
- Biosolids Handling: Solids Thickening
- Biosolids Handling: Anaerobic Digestion
- Biosolids Handling: Dewatering and Disposal
- Digester Gas Purification
- Water Reuse Pumping System (non-potable)

3.3 Component Overview

3.3.1 Headworks (Influent Fine Screening, Grit Removal, and Influent Flow Measurement)

Screening of raw influent occurs with a 6 mm mechanically cleaned fine screen. Emergency backup of the mechanical screen occurs with a manually cleaned bar rack with 2-inch spacing and grinder, also located in the Headworks Building.

Grit is removed by an aerated grit chamber, airlift pumps, and gravity grit classifier. These components are located downstream of the screening equipment.



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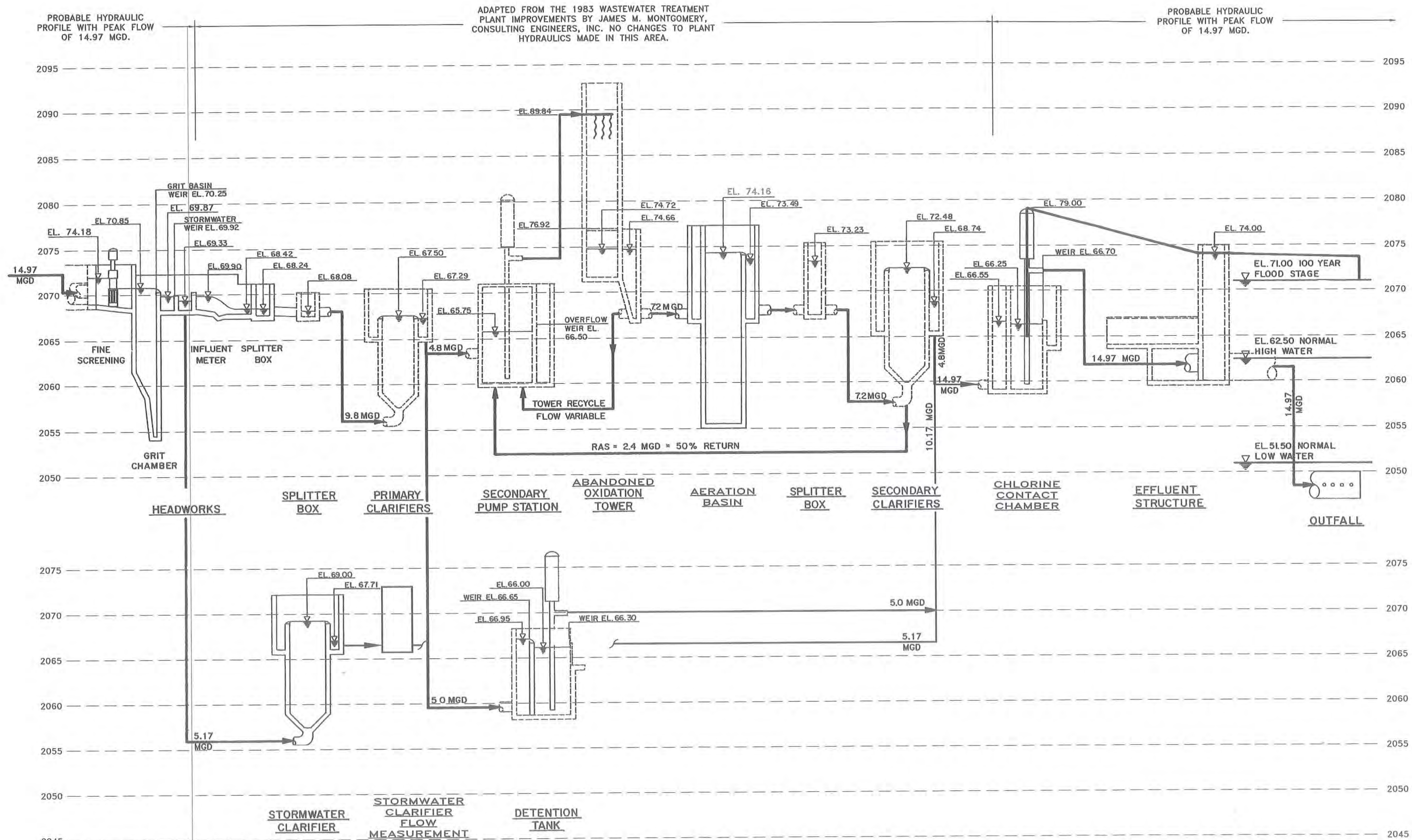
CAD FILE: 20-07-010_O&M FIGURES

CITY OF SANDPOINT
WASTEWATER TREATMENT PLANT O&M

PROCESS FLOW SCHEMATIC
FIGURE 3-1



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CAD FILE: 20-07-010_O&M FIGURES

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CITY OF SANDPOINT
WASTEWATER TREATMENT PLANT O&M

HYDRAULIC PROFILE
FIGURE 3-2

04/04 (JUB-A-FIGHOR2)

2008 - 2010 WWTP UPGRADES: DESIGN CRITERIA

NOTE: THE FOLLOWING DESIGN CRITERIA INCLUDES ITEMS CONSTRUCTED DURING THE IMPROVEMENTS INCLUDED HEREIN. FOR ADDITIONAL DESIGN CRITERIA INFORMATION, REFER TO THE 1983 WWTP IMPROVEMENTS RECORD DRAWINGS, J.M. MONTGOMERY CONSULTING ENGINEERS, 1983.

FLOW CONDITIONS: (MGD)

	AVG DAY	MAX MONTH	PEAK
EXISTING	2.79	5.05	14.00
DESIGN PERIOD(10yrs)	3.62	6.09	14.97

LOAD CONDITIONS: (PPD)

	AVG DAY	MAX MONTH	PEAK
BOD_5			
EXISTING	3,400	4,636	11,259
DESIGN PERIOD(10yrs)	5,054	6,873	16,678
TSS			
EXISTING	2,206	3,363	10,588
DESIGN PERIOD(10yrs)	3,897	5,924	18,707
NH_3 -N			
EXISTING	184	800	-
DESIGN PERIOD(10yrs)	604	1524	-

HEADWORKS

FINE SCREENING	
NUMBER	1
CAPACITY	6.5 MGD
SCREEN OPENING	6 MM
SCREENINGS WASHER-COMPACTOR	
NUMBER	1
CAPACITY	25 FT^3/HR
GRIT CLASSIFIER	
NUMBER	1
HYDRAULIC CAPACITY	200 GPM
STORMWATER CLARIFIER FLOW MEASUREMENT	
CLARIFIED EFFLUENT METER TYPE:	SHARP CRESTED WEIR
CAPACITY	10 MGD

SECONDARY TREATMENT

AERATION BASINS	
TYPE:	COMPLETE MIX
NUMBER:	2
DIMENSIONS (EACH):	25 FT X 55 FT
SIDEWATER DEPTH:	15 FT
VOLUME (TOTAL)	309,000 GAL
HYDRAULIC DETENTION TIME:	
AVERAGE DAY FLOW	2.04 HR
MAX-MONTH FLOW	1.72 HR (4.30 MGD)
DEPTH TO DIFFUSERS:	14.0 FT (MIN)
NUMBER OF DIFFUSERS	840
MAXIMUM SOTR	1080 LB O_2/HR
AIR REQUIREMENTS AT MAXIMUM SOTR	4116 SCFM
BLOWERS, CENTRIFUGAL	
QUANTITY	1
CAPACITY: 100hp	1,600 SCFM @ 6.5 PSIG
DRIVE	VFD
BLOWERS, POSITIVE DISPLACEMENT	
QUANTITY	2
CAPACITY: 50hp	820 SCFM @ 7.3 PSIG
100hp	1,440 SCFM @ 8.0 PSIG
DRIVE	VFD

DISINFECTION

DECHLORINATION	
CONTROL SCHEME	CHLORINE RESIDUAL BASED FEED
CARRIER WATER SUPPLY	
REQUIRED CAPACITY (@ INJECTOR)	15 GPM @ 40 PSI
SULFONATORS	
NUMBER	1
MAX CAPACITY (EACH)	240 LB/DAY
DUAL CYLINDER SCALES	
NUMBER	2
MAXIMUM STORAGE (INCLUDING ACTIVE CYLINDERS)	900 LBS

PRIMARY CLARIFIER PUMP SYSTEM

NUMBER	4
TYPE	ROTARY LOBE
CAPACITY: 10hp	100 GPM @ 50 PSI

WASTE ACTIVATED SLUDGE (WAS) PUMPS

NUMBER	2
TYPE	ROTARY LOBE
CAPACITY: 7.5hp	300 GPM @ 30 PSI

THICKENING

ROTARY SCREEN THICKENER (RST)	
NUMBER	1
CAPACITY, HYDRAULIC	200 GPM (NOMINAL)
INFLUENT SOLIDS CONCENTRATION	0.5 - 1.5 PERCENT
THICKENED SOLIDS CONCENTRATION	4.0 - 8.0 PERCENT
POLYMER FEED	
NUMBER OF PUMPS	2
TYPE	POSITIVE DISPLACEMENT/DIAPHRAGM
CAPACITY	20 GPH AT 3,000 CPS
POLYMER TANKS	
NUMBER (EXISTING)	2 (1)
EXISTING, CAPACITY (EACH)	350 GAL
THICKENED SOLIDS PUMPS	
NUMBER	1
TYPE:	ROTARY LOBE
CAPACITY (EACH)	100 GPM (MAX) @ 40 PSI

ANAEROBIC DIGESTION

PRIMARY HEAT EXCHANGER	
NUMBER	1
CAPACITY	455,000 BTU/HR

ENERGY RECOVERY

IRON SPONGE	80,000 SCFD

NON-POTABLE WATER (NPW) PUMPS

NUMBER	2
TYPE	VERTICAL TURBINE
CAPACITY:10hp	155 GPM @ 80 PSI
25hp	370 GPM @ 80 PSI

Influent flow measurement occurs at the Parshall flume equipped with a molded head gage graduated in feet and half-tenth intervals located downstream of the gravity grit channel. The Parshall Flume also includes an ultra sonic transducer mounted over the waterway to provide for electronic measurement of influent flow. Under flood stage conditions, a portion of flow will bypass the influent flow meter. This portion of flow is accounted for with the stormwater clarifier flow measuring weir upgraded with the 2008-2010 upgrades.

3.3.2 Primary Clarification, Stormwater Clarifier, and Primary Pump Station

Primary settling is accomplished with two parallel 60-foot diameter center feed, circular clarifiers. Clarifier effluent flows by gravity to the intermediate pump station and is then pumped into the aeration basins. Although the clarifiers were not modified in the 2008-2010 upgrades, the pumping system was replaced.

Peak flows during heavy I/I events are diverted to the stormwater clarifier and underflow pumping system. During the 2008-2010 upgrades the existing flow measurement system for the stormwater clarifier was retrofit with new equipment.

3.3.3 Biological Treatment

The aeration basins were upgraded with the 2008-2010 upgrades as follows:

- Added the ability to maintain a desired dissolved oxygen level in the basins by varying blower output using variable frequency drives.
- Added fine bubble aeration equipment to increase oxygen transfer rates.
- Added dissolved oxygen probes to provide monitoring capability, additional process control, and operating point feedback for system performance and control.
- Replaced a 50 hp and a 100 hp centrifugal blower with a 50 hp and 100 hp positive displacement blower.

3.3.4 Secondary Clarification

The secondary clarifiers, RAS pumping, and RAS pumping system were originally constructed in 1974. No modifications were made to the system during the 2008-2010 upgrades.

3.3.5 Disinfection System and Chlorine Contact Chamber

Disinfection of the clarified effluent occurs with addition of chlorine and sulfur dioxide for dechlorination. The Chlorine Contact Chamber (CCC) and chlorine injection system currently in use was initially constructed in 1974. Chlorine gas is injected into a site manhole between the clarifiers and upstream of the basin, providing contact time as effluent travels through the basin. The chlorine system was not modified as part of the 2008-2010 upgrades.

Dechlorination was added as part of the 2008-2010 upgrades and consists of a gas feed system and spray injection added to the CCC basin outfall. The dechlorination system utilizes sulfur dioxide gas to consume residual chlorine from the effluent to satisfy the current NPDES Permit limits for chlorine in the effluent.

3.3.6 Effluent Flow Measurement

Effluent flow is measured with a Parshall flume equipped with a molded head gage graduated in feet and half-tenth intervals located downstream of the Chlorine Contact Chamber. The Parshall flume also includes an ultra sonic transducer mounted over the waterway to provide electronic measurement of effluent flow. The effluent flow measurement was not modified as part of the 2008-2010 upgrades.

3.3.7 Biosolids Handling

The 2008-2010 upgrades included several upgrades to the biosolids handling system. These improvements include:

- Replacement of primary solids/transfer pumps with rotary lobe pumps.
- Replacement of the existing centrifugal waste activated sludge (WAS) pumps with new positive displacement rotary lobe pumps.
- Rotary screen thickener (RST) and pumping system was added to thicken WAS and primary settled solids to higher concentrations prior to anaerobic digestion; whereby increasing the solids residence time in the digester and improving performance.
- The anaerobic digester underwent improvements which included draining and removal of rags and debris from the digester interior, and re-coating of the lower 8-feet of the digester concrete walls.
- New mechanical valve upgrades and a new heat exchanger with increased capacity in the digester mixing system.
- Gas scrubbing equipment to utilize methane produced by the digester in the heating system boilers.

3.3.8 Water Reuse Pumping System (Non-Potable)

To mitigate potable water system demands within the plant, a non-potable water reuse system was constructed that pumps chlorinated effluent throughout the plant for plant-water uses (spray bars, wash water, etc). The pumped flow passes through a 500 micron automatic backwashing filter to remove residual particulate material prior to distribution throughout the WWTP.

3.3.9 Electrical Power and Controls

Avista Utilities provides electrical power to the Sandpoint WWTP. The 2008-2010 upgrades included electrical and controls systems updates to accommodate new equipment, provide improved reliability, and replace aging equipment. In the event of a normal power outage, an emergency generator will provide power for critical process equipment at the plant. The generator starts automatically and supplies power to all operating equipment, such as the headworks, pumping systems, blowers, clarifiers, etc.

3.4 List of Major Equipment and Suppliers

The following is a condensed list of the major equipment with contact names and numbers. Manufacturer's O&M literature provides additional contact information and is bound separately.

Table 3-1 - List of Major Equipment Suppliers (2008-2010)

Location	Equipment Item	Manufacturer	Supplier/ Representative	Contact Person	Phone
Headworks					
	Bandscreen System	JWC	Apsco	Dale McBain	800-791-6195
	Biofilter Blower	New York Blower	Baxter Air Engineering	Dan Bureau	425-486-6666
	Grit Classifier	WesTech	Goble Sampson	John Simon	425-392-0491
Aeration System					
	Fine Bubble Diffusers	EDI	Goble Sampson	John Simon	425-392-0491
	Blowers	Kaeser	Northwest Pump	Rick Fuqua	866-532-7215
Disinfection					
	Gas Disinfection (Dechlorination)	Wallace & Tiernan	Spokane Instrument	Bob Lithgow	509-292-8560
Solids Handling					
	Rotary Lobe Pumps (WAS, Primary, and TSL)	Vogelsang	Correct Equipment Inc.	Mark Thomas	425-869-1233
	Rotary Screen Thickener	FKC Co. Ltd.	Pedroni & Co.	Victor Pedroni	425-369-6164
	Polymer Metering Pumps	Grundfos Pump Corporation	Preferred Pump		425-869-1033
Plant Water Systems					
	Reuse Water Pumps	Peerless	Pump Tech, Inc.	Ed Smith	509-766-1547
Anaerobic Digester					
	Sludge Heat Exchanger	Gooch Thermal Systems	Goble Sampson	John Simon	425-392-0491
	Gas Purifier (Iron Sponge)	MARCAB	Pedroni & Co.	Victor Pedroni	425-369-6164

Chapter 4

Headworks

Chapter 4 – Headworks

4.1 General

Wastewater contains various materials that can interfere with aerobic treatment processes and equipment. Among these items are rags, grit, and large debris. Both rags and debris have the potential to plug orifices, pipes, and effluent launders, creating increased maintenance expenditures and decreased equipment life. Grit creates wear on system components and increases maintenance associated with removal from the aeration basins and clarifier. Therefore, it is desirable to remove these items before the wastewater enters the primary clarifiers, aeration basins, and other downstream processes.

Major items at the headworks include:

- Mechanically cleaned fine screen and screenings washer-compactor
- Emergency bypass channel bar screen
- Emergency bypass channel grinder
- Aerated grit chamber (not upgraded during 2008-2010)
- Airlift grit pumps and grit classifier
- Parshall flume flow measurement (primary flow path) (not upgraded during 2008-2010)
- Automatic sampler (not upgraded during 2008-2010)
- Stormwater clarifier flow measurement

The M02 sheets of the Record Drawings as well as photographs on **Figure 4-1** through **Figure 4-4** provide additional information of the headwork's major items. Note that the electrical systems inside the Screening Building must meet Class I, Division II requirements (NFPA 820) and include sufficient ventilation to maintain this classification. This classification extends 10-feet from both sides of the channel and 18-inches above the top of the channel for outdoor areas.

4.2 Screening Equipment (Headworks Building No. 1)

4.2.1 General

Flow enters the WWTP and headworks from 30-inch (east side) and 24-inch (west side) gravity sewers. These pipes transition into open channels upstream of the upgraded headworks facilities.

The headworks contains three parallel influent screening channels. The three channels are the:

- Primary Flow Channel (southwestern channel) - contains a 6mm mechanically cleaned bandscreen (and associated screenings washer compactor)
- Emergency Bypass Channel No. 1 - Contains a channel comminutor (grinder)

Figure 4-1 – Bandscreen and Washer/Compacter Grinder (Headworks Building No. 1)

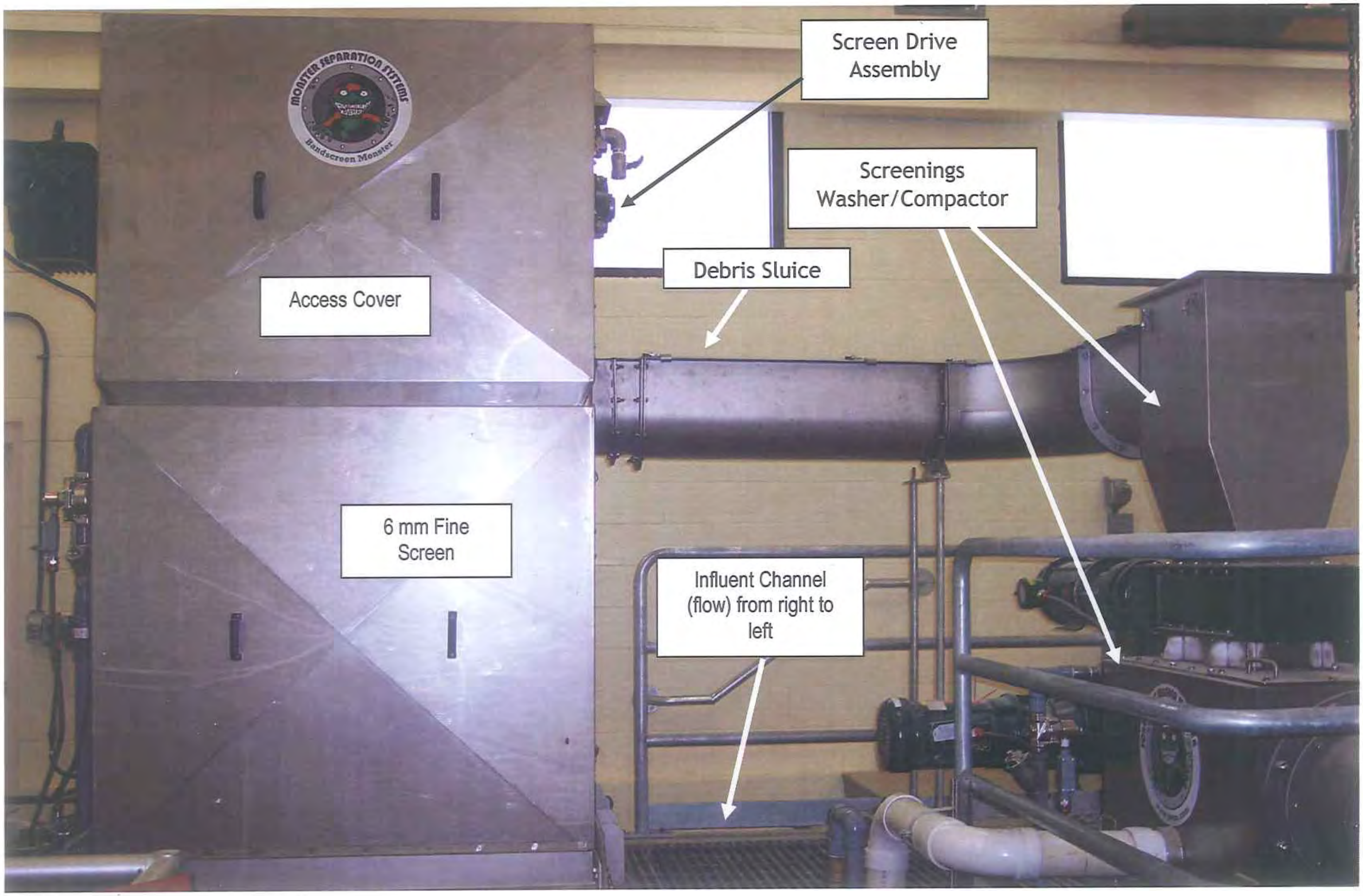


Figure 4-2 – Washer/Compacter and Screenings (Headworks Building No. 1)

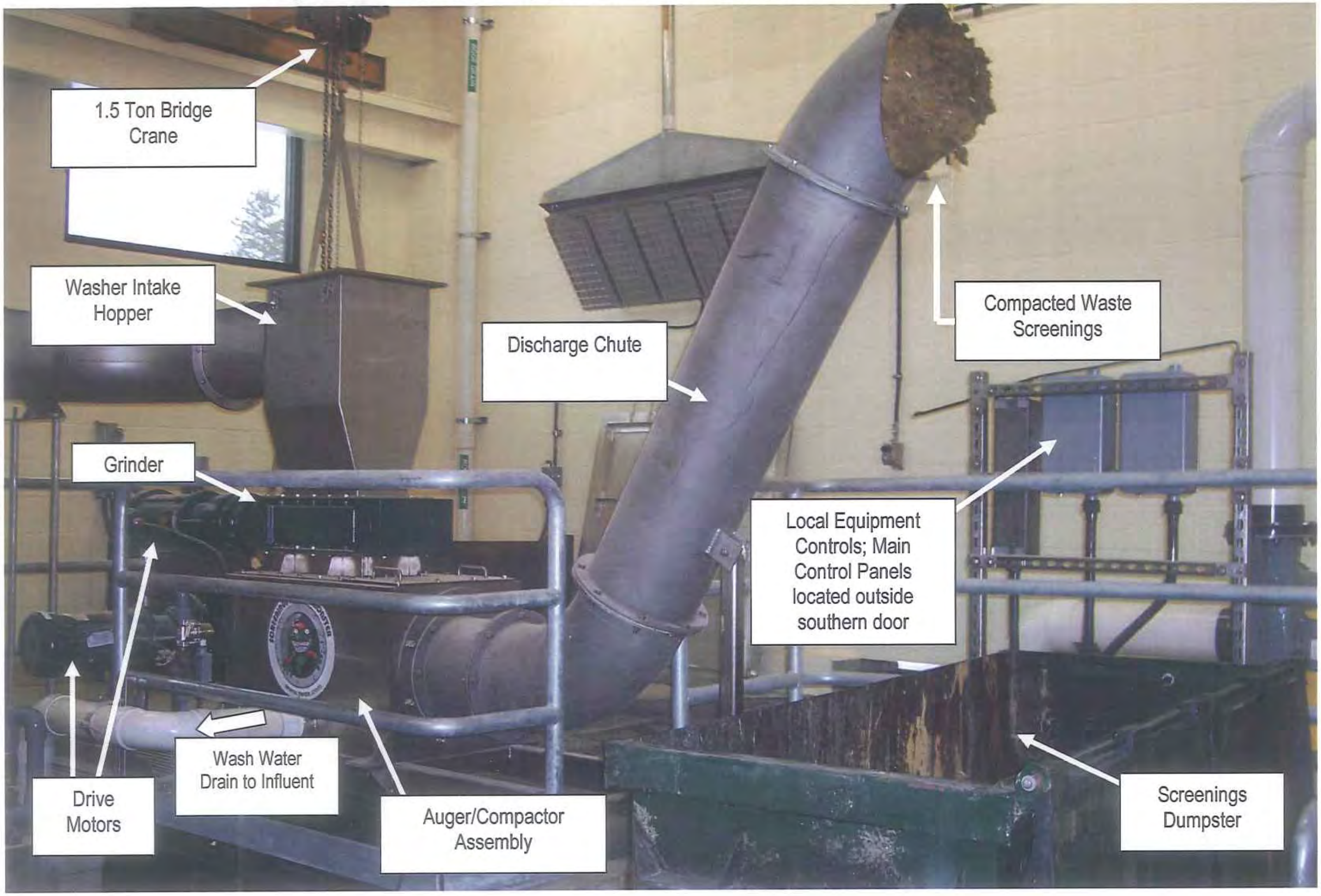


Figure 4-3 – Grit Classifier (Headworks Building No. 2)

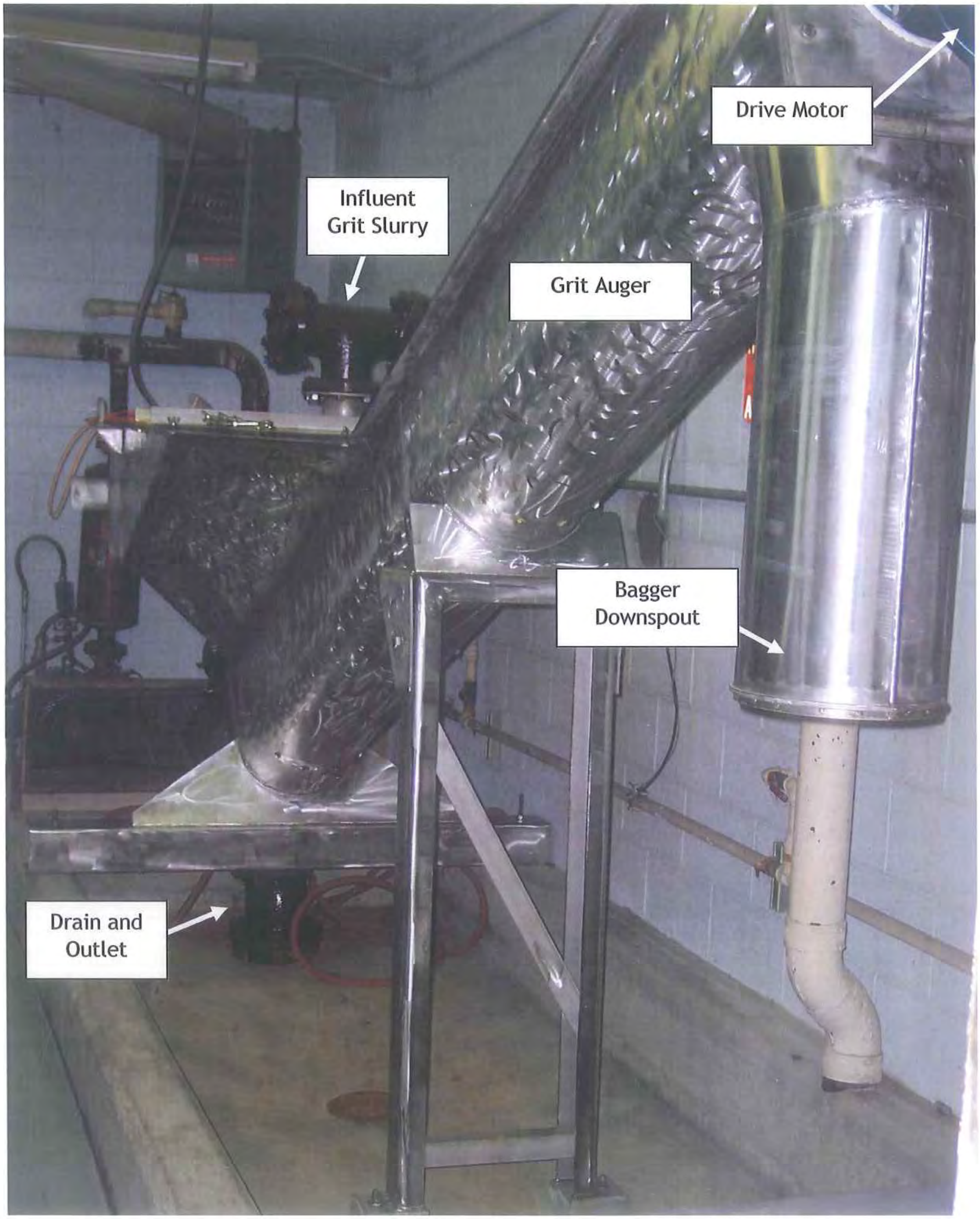
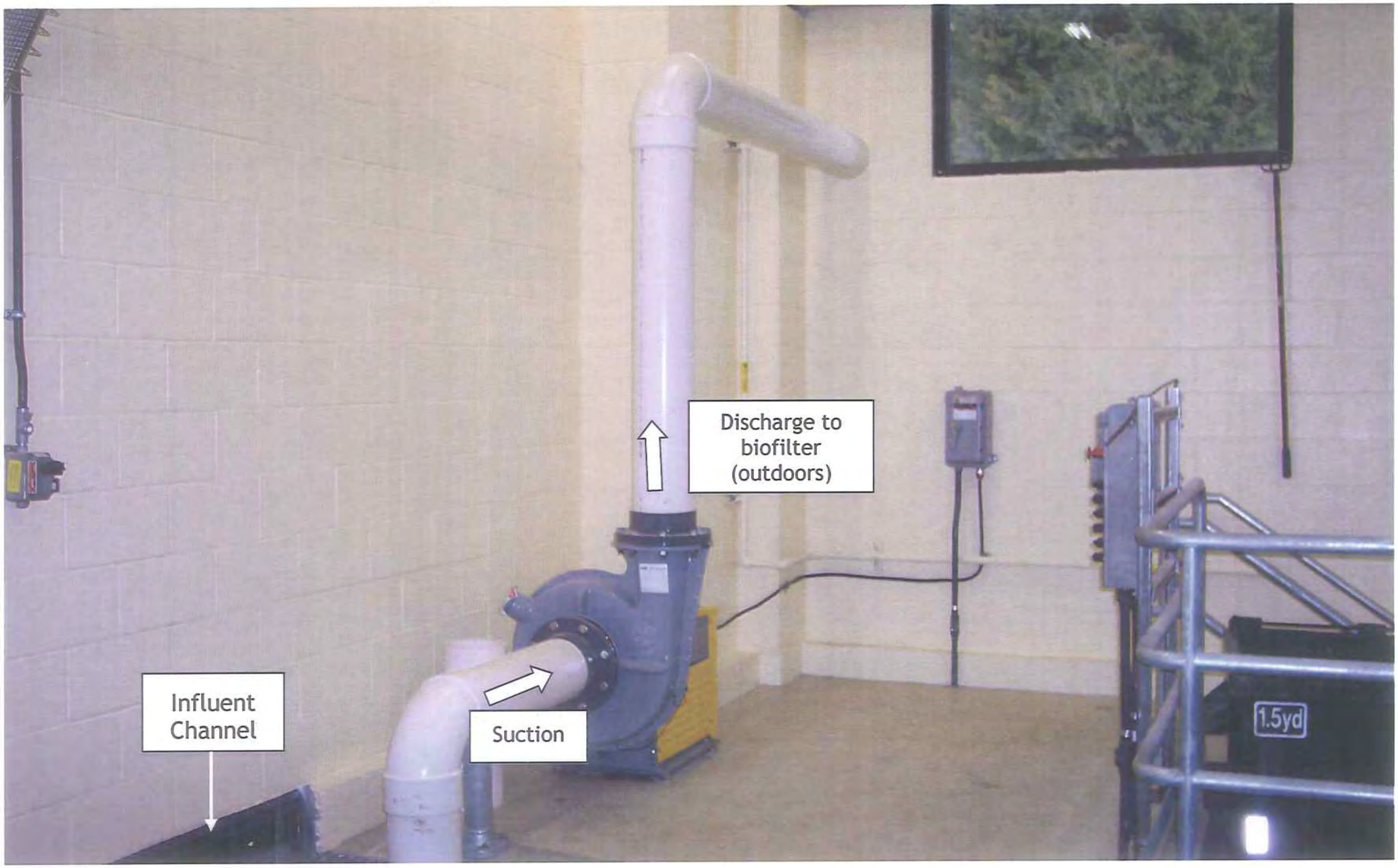


Figure 4-4 – Biofilter Blower (Headworks Building No. 1)



- Emergency Bypass Channel No. 2 - (northeastern channel) - contains a manually cleaned 2-inch bar rack with drain plate on top to allow screenings to be raked and dried prior to removal.

Stop gates in the channels allow flow isolation and diversion around the primary bandscreen channel to either of the emergency bypass channels to allow cleaning and maintenance activities. Additionally, the isolation gate in the center emergency bypass channel will allow flow to overtop the gate in the event the bandscreen becomes plugged or blocked with screenings. The emergency bypass channel is equipped with a high water alarm float that will energize the emergency channel No. 2 grinder motor and will call out a high-water alarm indicating a failure of the primary screening channel equipment.

The bandscreen equipment was supplied by APSCO, Inc. and manufactured by JWC Environmental, Inc. The operator should refer to the manufacturer's O&M Manual provided by the contractor prepared for the 2008-2010 Sandpoint Wastewater Treatment Plant Upgrades for detailed operation and maintenance procedures. Contacts for the screening equipment are:

JWC Environmental Western Region (Manufacturer)
Mark D. Bell, Senior Sales Manager
4235 South Victoria Circle
New Berlin, WI 53151
Phone: 262-785-9181
Fax: 262-785-9182
Email: markb@jwce.com

APSCO, INC. (representative)
Dale I. McBain
PO Box 2639
Kirkland, WA 98083-2639
Phone: 800-791-6195
Fax: 425-827-6171
Email: dmcbain@apsco-inc.com

4.2.2 Normal Operation

Under normal operating conditions, the operator should position the stop gates such that all flow routes to the Primary Flow Channel through the 6mm bandscreen. The bandscreen will screen influent wastewater under normal operating conditions consisting of flows up to approximately 6 million gallons per day (mgd).

4.2.3 High Flow Conditions

For high flow conditions, those exceeding 6 mgd (assuming the screen becomes blinded), flow will automatically overtop the gate upstream of the emergency bypass channels. These peak flows will then pass through either the Emergency Grinder Channel No. 1 or the Emergency Bar Rack Channel No. 2.

The position of the gates in the emergency channels will allow flow to pass through the grinder channel for flow conditions of 6 to 9 mgd. This type of operation will force flow through the grinder channel, which will shred debris rather than remove it from the waste stream. The operator should note that the primary bandscreen is capable of passing flows greater than 6 mgd; however, under these conditions, the upstream water depth will begin to rise substantially and will reduce freeboard in the influent channels to uncomfortable levels (i.e., less than 12 inches).

4.2.4 Extreme Flow Conditions

At extreme flow conditions exceeding 9 mgd, the function of the bandscreen and grinder are compromised. Under these conditions, the operator should remove all gates for Emergency Bypass Channels No. 1 and No. 2 allowing both channels to operate in parallel with minimal backwater effects, thus creating the highest hydraulic capacity through the headworks.

Utilize this same operational scheme over weekends or periods when the plant may be unattended for extended periods. This will allow flow to pass through either of the channels in the event that excessive rags or debris plug/block the primary bandscreen system.

4.3 Headworks Odor Control Equipment

Odor control at the WWTP is critical, as the facility is located in a predominantly residential neighborhood and adjacent to several public access facilities. To manage a portion of the odors, Headworks Buildings No. 1 and No. 2 have been equipped with centrifugal blowers to move air out of the buildings and force it through a self-contained biofilter.

Foul air from Headworks Building No.1 is pulled from the headspace within the headworks channels. Air is contained within this headspace by ¼" thick EPDM rubber mats that are rolled across the top of the influent and headworks channels. The foul air blower **(see Figure 4-4)** pulls air from the channels and discharges it directly to the biofilter. The biofilter located northwest of Headworks Building No. 1 should be maintained for continued odor removal. Maintenance involves wetting the media regularly and replacing the media when odor breakthrough occurs.

New York Blower manufactured the biofilter blower equipment. The operator should refer to the manufacturer's O&M Manual for detailed operation and maintenance procedures. Contacts for the equipment are:

The New York Blower Company (Manufacturer)
7660 Quincy Street
Willowbrook, Illinois 60521-55956
Phone: 630-794-5700
Fax: 630-794-5776

Baxter Air Engineering (representative)
12625 NE Woodinville
Woodinville, WA 98072
Phone: 425-486-6666
Fax: 425-486-8260

4.4 Aerated Grit Chamber and Classification System

The aerated grit chamber was not modified as part of the 2008-2010 upgrades. The grit removal system consists of an aerated grit chamber downstream of the screen/grinders and upstream of the primary clarifiers. Two 15 hp blowers are used to introduce air near the bottom at one side of the basin to create a rolling motion of the water. The rolling action is intended to keep organic material suspended while allowing the higher specific gravity grit and sand to settle at the bottom of the basin. Accumulated grit is pumped to a classifier in Headworks Building No. 2 for washing and disposal.

The grit chamber has a reported hydraulic capacity of approximately 14.7 mgd; however, its performance is compromised at all flow levels compared to current grit removal techniques (i.e., vortex grit chambers). The new 6 mm fine screen has significantly reduced large grit from entering the grit chamber; however, it is likely that grit is accumulating in downstream processes.

During the 2008-2010 upgrades, the grit classifier located in the Headworks Building No. 2 was replaced with a new unit. Grit slurry from the bottom of the aerated grit chamber is pumped to the grit classifier with the existing air-lift grit pumps. The air-lift pump expansion chambers were elevated to accommodate the additional height of the new classifier inlet piping.

The upgrades also include new floor drainage sumps with flushing lines within the Headworks Building No. 2 to allow dewatering of grit prior to landfilling. Leachate collected in the sumps from the grit bags is flushed back to the aerated grit chamber. A photograph of the Grit Classification System appears on **Figure 4-3.**

The grit classifier was supplied by Goble Sampson and manufactured by WesTech, Inc. The operator should refer to the manufacturer's O&M Manual for detailed operation and maintenance procedures. Contacts for the classifier are:

WesTech Headquarters (Manufacturer)
3625 S. West Temple
Salt Lake City, UT 84115
Phone: 801-265-1000

Goble Sampson Associates (representative)
John Simon
1275 12th Avenue NW, Suite 5
Issaquah, WA 98029
Phone: 425-392-0491
Fax: 425-392-9615

4.5 Automatic Sampling and Influent Flow Measurement

The existing influent automatic sampler and influent Parshall flume were not modified or upgraded during the 2008-2010 upgrades. Effluent from the grit chamber is directed to either the stormwater clarifier or to the primary clarifiers. A majority of the plant flows are routed through the 18-inch Parshall flume for primary and secondary treatment. The influent flume has a rated free-flow capacity of 15.9 mgd, provided no backwater effects exist.

The stormwater clarifier periodically has to be pumped down as it accumulates raw water by using the solids underflow pump. This pump discharges to the headworks channel downstream of the influent Parshall flume to avoid counting influent flows twice.

Chapter 5

Primary Clarification and Stormwater Clarification

Chapter 5 – Primary Clarification and Stormwater Clarification

5.1 Primary Clarification

5.1.1 Component Description

The primary clarifiers are downstream of the influent Parshall flume and upstream of the secondary pump station beneath the Control Building. A division box downstream of the influent Parshall flume receives raw wastewater, overflow from the gravity thickener and secondary anaerobic digester, and drainage from the Dewatering Building. The primary clarifiers are shown on **Figure 5-1**.

During most conditions, all influent flow is routed through the primary clarifiers; however, during peak flow events, a portion of the flow is diverted to the stormwater clarifier. The clarifier drives were replaced several years ago, and the scrapers were cleaned and painted at that time.

Settled solids in the primary clarifiers are pumped using the Primary Solids Pump Station, which is discussed in Chapter 9.

Figure 5-1 – Primary Clarifiers

5.1.2 Primary Clarifier Capacity

The capacity of the primary clarifiers when both are in service is approximately 9.5 mgd based on an overflow rate of 2,000 gallons per day per square foot (gpd/sf). Based on the process schematic from the 1983 construction drawings, flow to the clarifiers is limited to approximately 9.3 mgd (assuming 4.3 mgd is routed to the aeration basins through the secondary pump station, and the overflow sump pumps deliver 5.0 mgd to the Chlorine Contact Chamber).

Table 5-1 summarizes the primary clarifier loading and performance under current conditions compared to literature design guidance. With the limiting capacity at 9.3 mgd, primary clarification can be provided to include a majority of the flows that reach the treatment plant. During normal flows in the range of 2.5 to 5.0 mgd, the units are loaded more lightly, allowing efficient removal of suspended solids and BOD_5.

The plant currently diverts flow during peak flow periods to the stormwater clarifier. Maximum day flows from 1998 through 2005 were reported limited to 7.0 to 7.5 mgd. Based on data available from the facility, up to 50 percent of TSS and BOD will be removed from the clarifier effluent, which will assist in protection of receiving water (Pend Oreille River) quality. The primary clarifiers could be expected to remove approximately 30 percent of influent BOD on a 90^{th} percentile basis.

Table 5-1 - Primary Clarifiers Performance Summary

Parameter	Actual Condition	Typical Design Condition
Diameter (ft)	55	---
Surface Area (sf)	2,375	---
Volume, Each (gal)	140,000	
BOD_5 Removal (%)	54% ±15%	25-40%
TSS Removal (%)	54% ±15%	50-70%
Overflow Rate with Both Units in Service (gpd/sf)		
Average Flow – 2.79 mgd	587	800-1,200
Peak Day – 9.3 mgd [a]	1,960	2,000-3,000
Hydraulic Residence Time, HRT (hr)		
Average Flow – 2.79 mgd	2.6	1.5-2.5
Peak Day – 9.3 mgd [a]	0.72	1.0

[a] *Peak minus selective diversion to stormwater clarifier allowable for downstream pumping*

5.2 Overflow Pumps and Overflow Meter Vault

A portion of the influent wastewater may be diverted prior to the aeration basins to protect the downstream biological process from washout during high flows. The overflow sump receives primary clarifier effluent that is in excess of the amount pumped to the activated sludge secondary treatment system. The excess flow enters the pumping basin by overflowing a divider wall that cannot be adjusted. Two 7.5 hp vertical turbine pumps rated at 1,725 gpm each (2.5 mgd) at 10 feet TDH pump the excess flow from the influent pipe to the Chlorine Contact Chamber. There, the flow is combined with the secondary clarifier effluent for disinfection and discharge to the Pend Oreille River. The overflow pumps are shown on **Figure 5-2.**

Figure 5-2 – Overflow Pump Station

5.3 Stormwater Clarifier

5.3.1 Component Description

The stormwater clarifier was constructed in the mid-1980s to treat influent flows that exceed the capacity of the primary clarifiers and secondary treatment units. The stormwater clarifier allows for settling prior to flow entering the Chlorine Contact Chamber for disinfection. This process is important for maintaining the integrity of the secondary (biological) treatment system during extreme I/I flows. As noted above, the capacity of the primary clarifiers is 9.3 mgd. Flows in excess of 9.3 mgd are diverted to the stormwater clarifier using downward opening slide gates. A submersible sludge pump is located on the northwest corner of the clarifier. The pump is used to retrieve settled solids upstream of the primary clarifiers.

5.3.2 Capacity

The bypass capacity of the stormwater clarifier is approximately 4.8 mgd, which is based on an overflow rate of 2,000 gpd/sf. A summary of operating conditions is shown in **Table 5-2**.

Table 5-2 - Stormwater Clarifier Bypass

Parameter	Actual	Recommended	Units
Diameter	55	---	Feet (ft)
Surface Area	2,375	---	Square Feet (sf)
Volume	157,000	---	Gallons (g)
Overflow Rate			
Peak Day (observed) [a]	1,473	2,000	gpd/sf
Peak Day (estimated) [b]	1,979	2,000	gpd/sf

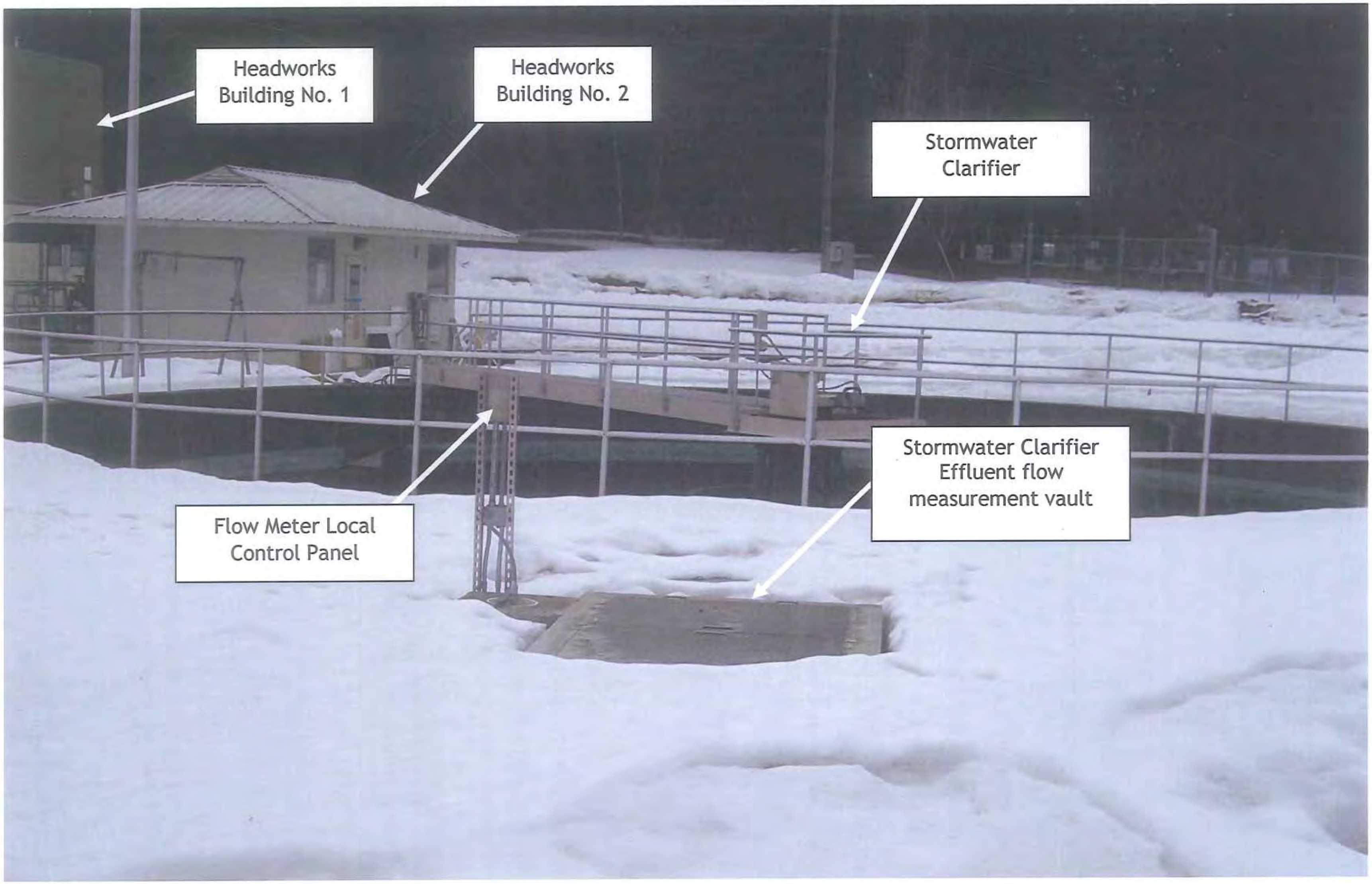
[a] *Peak Day (observed) flow of 12.8 mgd minus 9.3 mgd assumed to the primary clarifiers and aeration basin*

[b] *Peak Day (estimated) flow of 14.0 mgd minus 9.3 mgd assumed to the primary clarifiers and aeration basin*

5.3.3 Stormwater Clarifier Flow Measurement

As part of the 2008-2010 upgrades the flow measurement equipment for the stormwater clarifier was upgraded. The equipment used for measuring the flows includes a 6-foot-wide sharp crested weir, stilling well, and ultrasonic level indicator. Periodically the operator will need to clean the stilling well inlet ports to remove grease, rags, and debris to obtain an accurate flow reading. Flow transmits back to the plant Control Building and is totalized via a second pen on the plant influent chart-recorder. The stormwater clarifier flow measurement vault is shown on **Figure 5-3**.

Figure 5-3 – Stormwater Clarifier Flow Measurement



Chapter 6

Biological Treatment

Chapter 6 – Biological Treatment

6.1 General

Biological treatment at the Sandpoint WWTP occurs in Aeration Basin No. 1 and No. 2 after screening and grit removal in the headworks and primary settling. The major upgrades to the aeration system in 2008-2010 include:

- Fine bubble diffused air system
- Dissolved oxygen monitoring system
- Variable speed drives and air flow measurement on each blower
- A new 50 HP positive displacement blower
- A new 100 HP positive displacement blower

This chapter discusses the above items in addition to overall process theory and process control. The aeration system upgrades appear on the M03 sheets of the Record Drawings with photographs on **Figure 6-1** through **Figure 6-4**.

6.2 Secondary Pump Station

The secondary pump station, or Breeze-Way pump station, is located in the central portion of the Lab Building. The pumps convey primary clarifier effluent to the biological treatment system. There are two independent sumps with two pumps each for redundancy. The pumps were originally installed to pump to the oxidation tower, which was abandoned in the mid-1980s with construction of the current aeration basins.

The pumps currently installed are rated at 750 gpm and 22 feet TDH, and discharge through an 18-inch force main. The static lift is approximately 10 feet to the aeration basins. The design influent rate for the aeration basins was approximately 4.8 mgd, according to the design criteria in the 1983 construction plans.

6.3 Oxidation Tower

A wood (with wood slat media) oxidation tower was constructed in the 1970s as the first biological treatment process. The tower has been out of service for some time, with no plan to return it to service.

6.4 Aeration Basins

6.4.1 Component Description

The two aeration basins are constructed of concrete and configured to be operated in parallel. The basins may also be operated in series if the effluent weir gates are raised in one basin and lowered in the other; this will result in flow through one basin into another before discharging to the secondary clarifiers. Each basin is 25 feet wide and 55 feet long, with a side water depth of 15 feet, resulting in a volume of approximately 154,000 gallons each.

Aeration is provided by centrifugal or positive displacement blowers fine bubble diffusers, which are discussed in a subsequent section. **Figure 6-1** is a photograph of the aeration basins.

Figure 6-1 – Aeration Basins

6.4.2 Capacity

The activated sludge system apparently was designed for organics (BOD) removal, but not for nitrification of nitrogen compounds (e.g., conversion of total Kjeldahl nitrogen [TKN] and ammonia to nitrates). The 1982 wastewater facilities plan indicated a capacity of 1,500 lb/day of BOD_5, presumably for average day conditions. The design also indicated a food to microorganism (F:M) ratio of 0.27 to 0.31 lb BOD_5/lb mixed liquor volatile suspended solids (MLVSS), with a MLSS of 2,500 to 3,000 mg/l.

The basins are currently operated at approximately 1,000 mg/l MLSS, with a single basin used for treatment. Flow to the aeration basins from the secondary pump station is limited to 4.3 mgd (3,000 gpm), according to plant operators. The design criteria for the 1983 upgrades indicated a capacity of 4.8 mgd. At current loading of BOD_5 on the treatment plant, and BOD5 removal of 30 to 50 percent by the primary clarifiers, the operating parameters of the activated sludge system are as shown in **Table 6-1**. The treatment plant currently appears to be meeting permit requirements for BOD_5 and TSS removal under these operating conditions.

Table 6-1 - Single Aeration Basin Loading Parameters

	Primary Clarifier 50% BOD_5 Removal		Primary Clarifier 30% BOD_5 Removal		
BOD Loading	F:M [a]	SRT [b]	F:M [a]	SRT [b]	HRT [c]
Average Annual Load	1.3	1.0	1.9	.7	0.95 hr
Maximum Month Load	1.8	0.7	2.6	0.5	0.57 hr
Maximum Day Load	4.9		6.8		0.57 hr

a. *Based on MLSS = 1,000 mg/l*

b. *Assumed Yn (net sludge yield) = 0.8 lb MLSS growth/lb BOD*

c. *Based on average annual flow plus 50 percent RAS recycle*

The treatment plant currently is meeting the BOD_5 and TSS limits of the discharge permit, with the activated sludge operating parameters shown in **Table 6-1**. BOD_5 removal is possibly limited after the F:M loading rate reaches about 3 lb BOD/lb MLSS, on an average (e.g., maximum month average) basis.

Using accepted carbonaceous BOD (CBOD) removal kinetic parameters and an effluent soluble CBOD objective of 15 mg/l, the limiting CBOD loading rate on the aeration basins is calculated as shown in **Table 6-2**. The loading rates are presented for a reasonable range of MLSS concentrations, and the range of temperatures experienced from 2002 to 2005, based on plant records. **Table 6-2** also contains calculated solids retention time (SRT) for the noted temperatures. The calculated loading capacity of the activated sludge system with two basins in operation during winter months is approximately 2,600 lb/day of CBOD (with an MLSS of 2,000 mg/L), and 3,900 lb/day (with an MLSS of 3,000 mg/L). The maximum calculated capacity is 640 lb/day during winter operation, with a single basin in operation at an MLSS of 1,000 mg/L.

Table 6-2 - Aeration Basin BOD_5 Loading Capacity (maximum month)

# Basins	MLSS, mg/l	Capacity CBOD, lb/day, for 15 mg/l effluent soluble CBOD				
		T = 20° C	T = 15° C	T = 12° C	T = 10° C	T = 8° C
1	1,000	1,150	910	790	700	640
1	2,000	2,300	1,820	1,580	1,400	1,280
2	2,000	4,600	3,700	3,200	2,800	2,600
2	3,000	6,900	5,500	4,800	4,200	3,900
Calculated SRT, days		2.2	3.2	4.1	4.9	6.1

Performance to date has exceeded these calculated limits, however. The plant is currently operating satisfactorily with a single aeration basin in operation and a loading of approximately 1,700 lb/day (with an MLSS of 1,000 mg/L). Because this level of operation is greater than expected by kinetic modeling, the basins are assumed to be organically limited at current flows and loads. Use of the second aeration basin will allow for additional capacity.

The aeration basin SRT (also referred to as mean cell residence time [MCRT] and sludge age) is the limiting factor for maintenance of viable bacterial populations. Generation time for organisms capable of oxidizing carbonaceous BOD is relatively fast, much less than one day, which allows operation at SRT of one day or less while still achieving good BOD_5 removal. However, the required SRT is longer for organisms that are capable of oxidizing reduced nitrogen (TKN and ammonia) to nitrates (nitrification). By operating with SRT less than approximately 2 days, the bacterial population capable of nitrification will not be sustained and minimal or no nitrification will take place. Complete nitrification only can be assured at SRT greater than approximately 5 days in the summer and approximately 12 to 17 days during winter operation (depending on temperature). Below these values, partial nitrification occurs, causing production of nitrites, which inhibits chlorine disinfection. The chlorine is consumed by partial nitrification byproducts, nitrites, and low concentrations of ammonia, causing the disinfection system to fail in its primary function, bacterial kill. Because the degree of nitrification varies through the diurnal cycle of treatment system operation, it becomes a daunting task to control the chlorine residual and achieve consistent disinfection.

In order to maintain BOD removal rates at higher loadings, increasing MLSS concentration and operating the second aeration basin appears to be necessary. This will create conditions where SRT sometimes will be high enough for nitrifying bacterial populations to become established and partially oxidize nitrogen compounds at least a portion of the time during summer temperature conditions. This will cause the chlorine disinfection system to become more difficult to operate. The system does not appear to be adequate for assured year-round nitrification performance, due to the inability to maintain adequate SRT at low temperatures.

6.5 Aeration Equipment – Diffusers and Blowers

6.5.1 General

The aeration basins were originally constructed in 1982 with coarse bubble aeration equipment. The 2008-2010 upgrades include removal of the coarse bubble diffusers and the installation of 9-inch-diameter disk-type fine bubble membrane diffusers. The M03-sheets of the Record Drawings show the aeration basins, the diffusers, and related details.

The diffusers are manufactured by Environmental Dynamics Inc. (EDI) Aeration Equipment and supplied by Goble Sampson and Associates. The operator should refer to the manufacturer's O&M Manual for detailed operation and maintenance procedures. Contacts for the diffusers are:

Environmental Dynamics, Inc. (manufacturer)
5601 Paris Road
Columbia, MO 65202
Phone: 573-474-9456
Fax: 573-474-6988

Goble Sampson Associates (representative)
John Simon
1275 12th Avenue NW, Suite 5
Issaquah, WA 98029
Phone: 425-392-0491
Fax: 425-392-9615

The aeration basins were originally constructed in 1982 with one 50 hp and two 100 hp centrifugal blowers providing air for both the aeration basins. The most recent upgrades occurred in 2008-2010 with the installation of variable speed drives on the blowers to vary aeration supply to match the required biological demands. Additionally, Blowers No. 1 (100 hp) and No. 2 (50 hp) were replaced with positive displacement (PD) blowers.

The blowers are shown on **Figure 6-2**. A mass air-flow meter is shown on **Figure 6-3**, and the control panel for the blowers is shown on **Figure 6-4**. The aeration basins, diffusers, and dissolved oxygen sensor are shown on **Figures 6-6**, **6-7**, and **6-8**, respectively.

The positive displacement blowers are manufactured by Kaeser and supplied by Northwest Pump and Equipment. The operator should refer to the manufacturer's O&M Manual for detailed operation and maintenance procedures. Contacts for the blowers are:

Kaeser Blowers (manufacturer)
Troy Belnap
PO Box 946
Fredericksburg, VA 22404
Phone: 801-671-5222

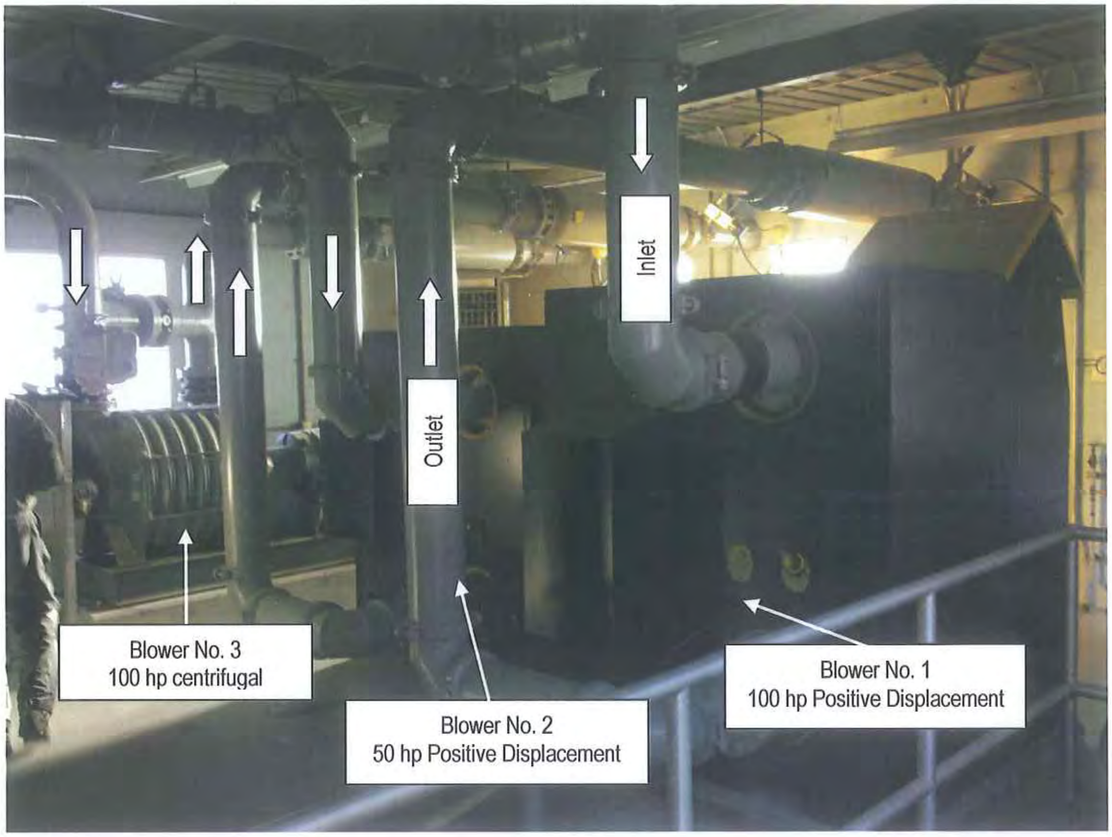
Northwest Pump and Eqpt. (representative)
Rick Fuqua
6015 E Valleyway Ave
Spokane Valley, WA 99212-1096
Phone: 866-532-7215

6.5.2 Aeration Equipment Specifications

The following specifications apply to the aeration equipment:

1. Aeration Basins
   a. Number of basins: 2
   b. Number of drop legs to diffusers per basin: 4
   c. Number of diffusers per drop leg: 105
   d. Total number of diffusers: 840 total, 420 per basin
   e. Submergence: 13.35 feet
   f. Max Flux Allowable 6 scfm/diffuser
   g. Expected standard oxygen transfer rate (SOTR) at varying conditions:
      - Existing Average, BOD only: 2,300 lb O_2/day
      - Projected Average, BOD & Ammonia (with nitrification): 6,500 lb O_2/day
      - Maximum Month, BOD only: 3,800 lb O_2/day
      - Peak, BOD only: 13,300 lb O_2/day
2. Blower No. 1 - Positive Displacement Rotary Lobe Blower
   a. Number of units: 1
   b. Model #: Kaeser FB620C CompaK Plus
   c. Motor: 100 hp; 3,600 rpm; 3 phase; 60 hertz; 460 volts
   d. Speed: Variable from 18 to 60 hz
   e. Performance: 1,440 scfm at 8.0 psig
3. Blower No. 2 - Positive Displacement Rotary Lobe Blower
   a. Number of units: 1
   b. Model #: Kaeser EB420C CompaK Plus
   c. Motor: 50 hp; 3,600 rpm; 3 phase; 60 hertz; 460 volts
   d. Speed: Variable from 18 to 60 hz
   e. Performance: 820 scfm at 7.3 psig
4. Blower No. 3 - Centrifugal Blower
   a. Number of units: 2
   b. Model #: Lamson 817-AD
   c. Motor: 100 hp; 3,600 rpm; 3 phase; 60 hertz; 460 volts
   d. Speed: Variable from 55 to 60 hz
   e. Performance: See blower performance on **Figure 6-5**

Figure 6-2 – Blowers



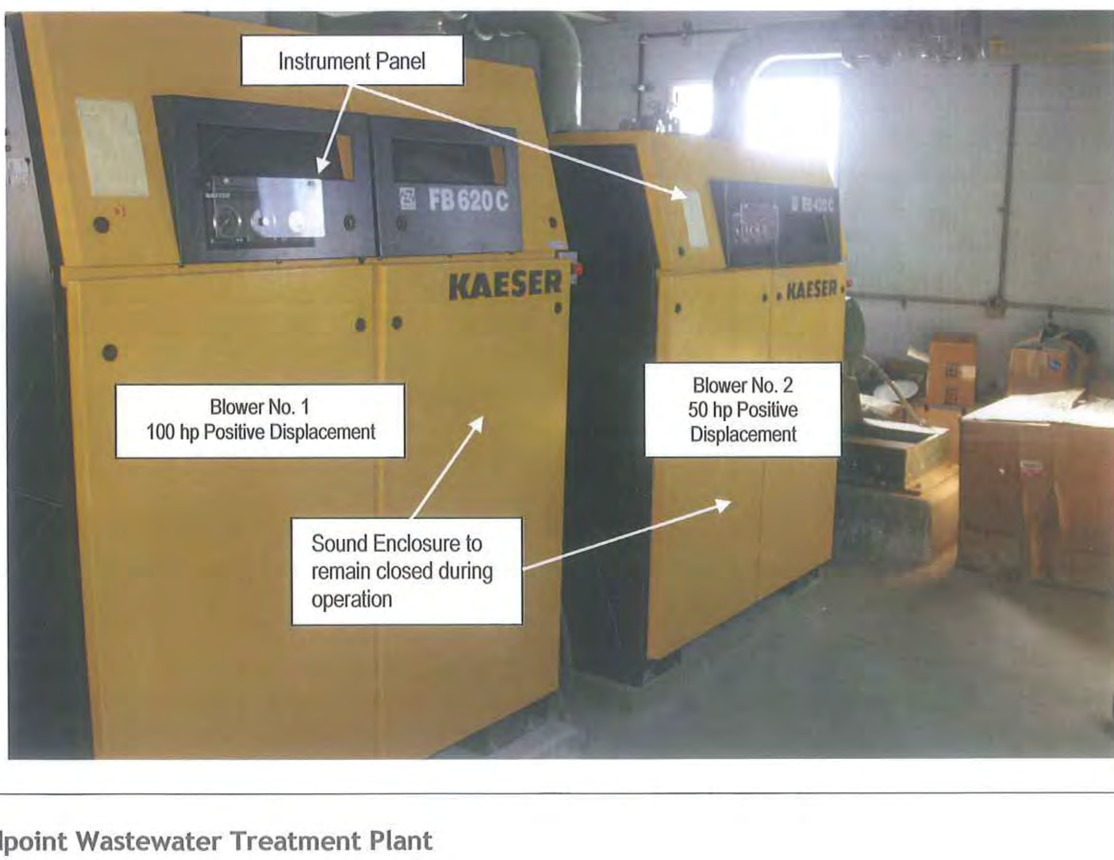


Figure 6-3 – Mass Flow Meter for Blower No. 2, 50 hp (Typical Installation)

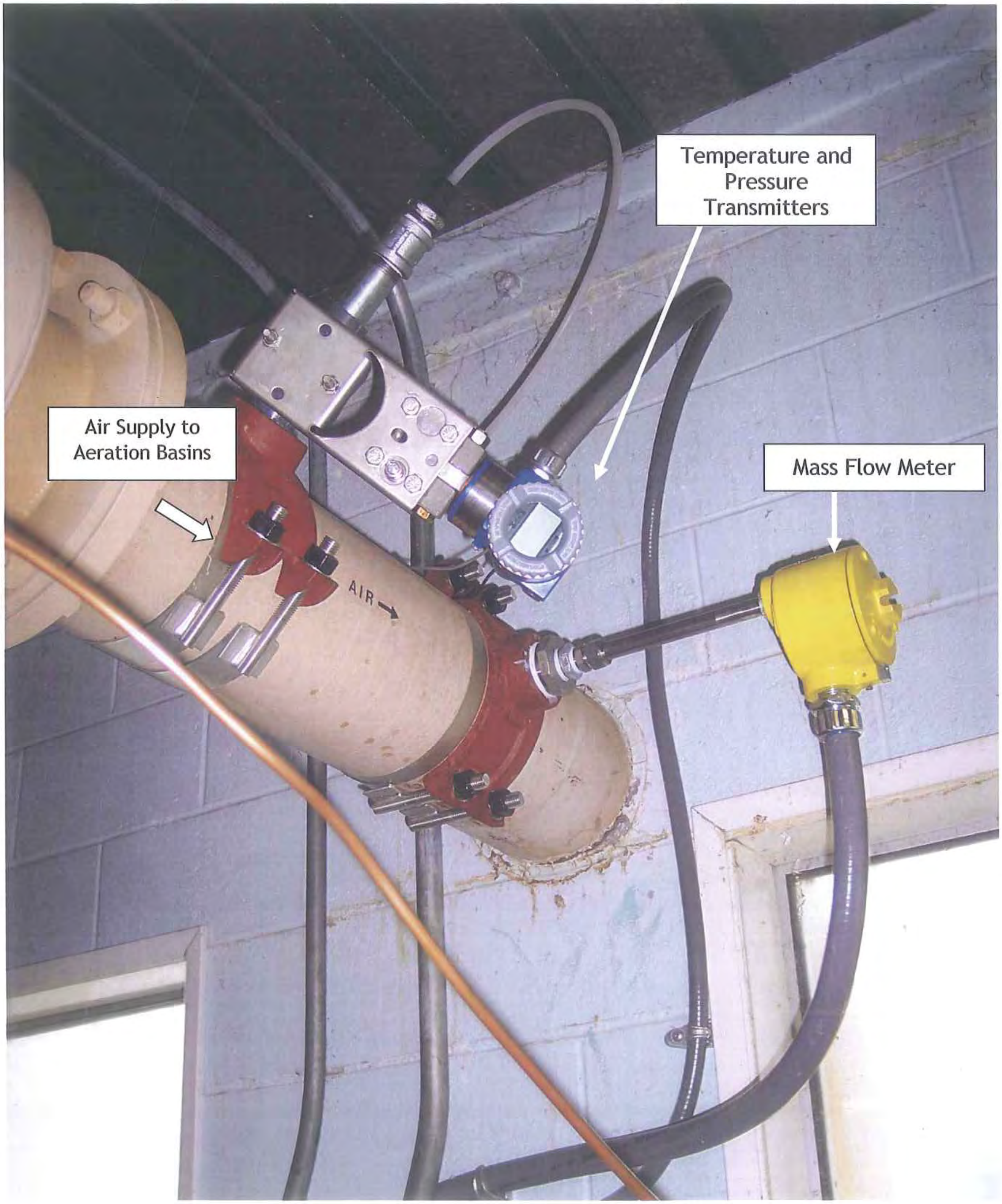


Figure 6-4 – Blower Room Control Panel

Figure 6-5 – 100 hp Centrifugal Blower Performance Curve

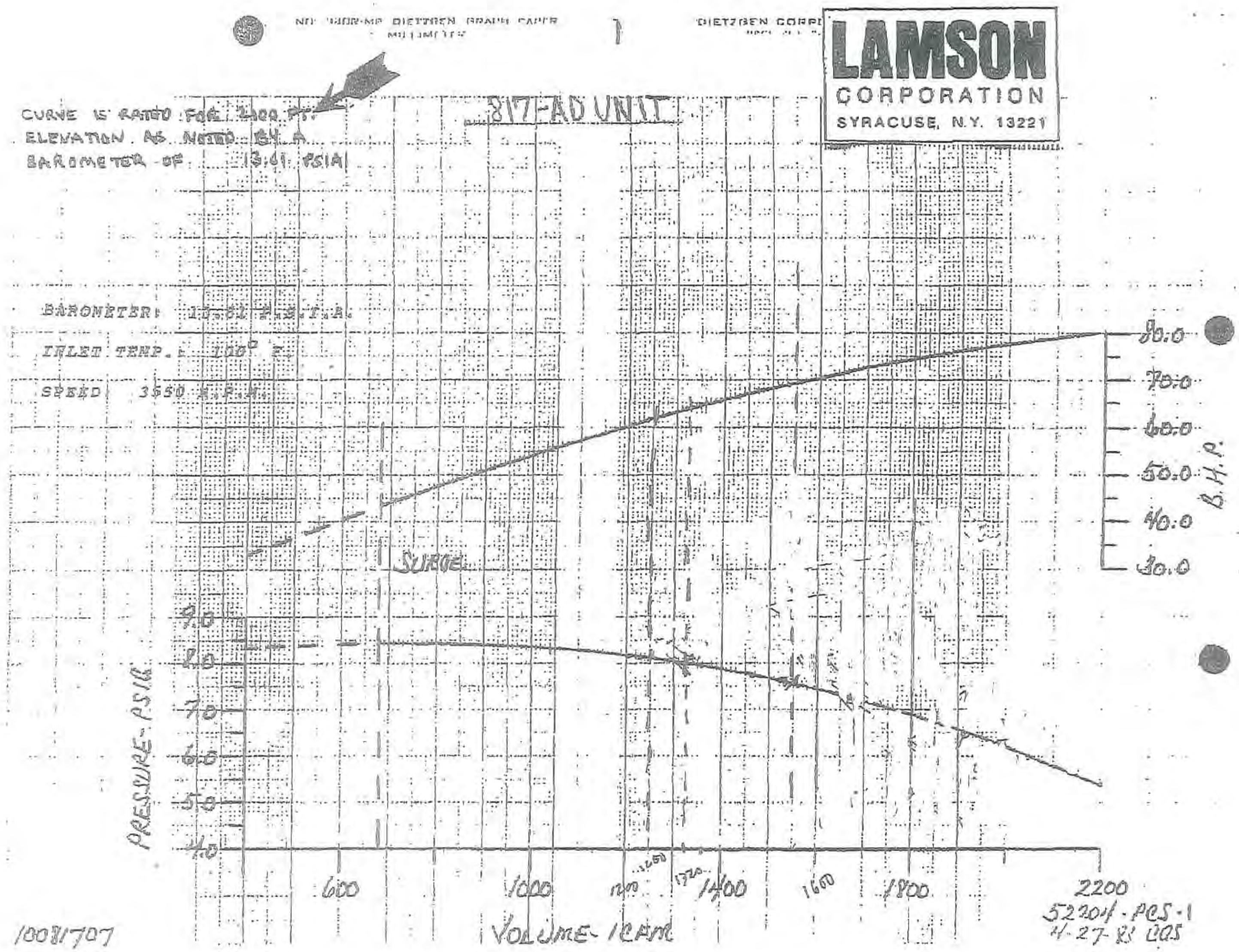


Figure 6-6 – Aeration Basins

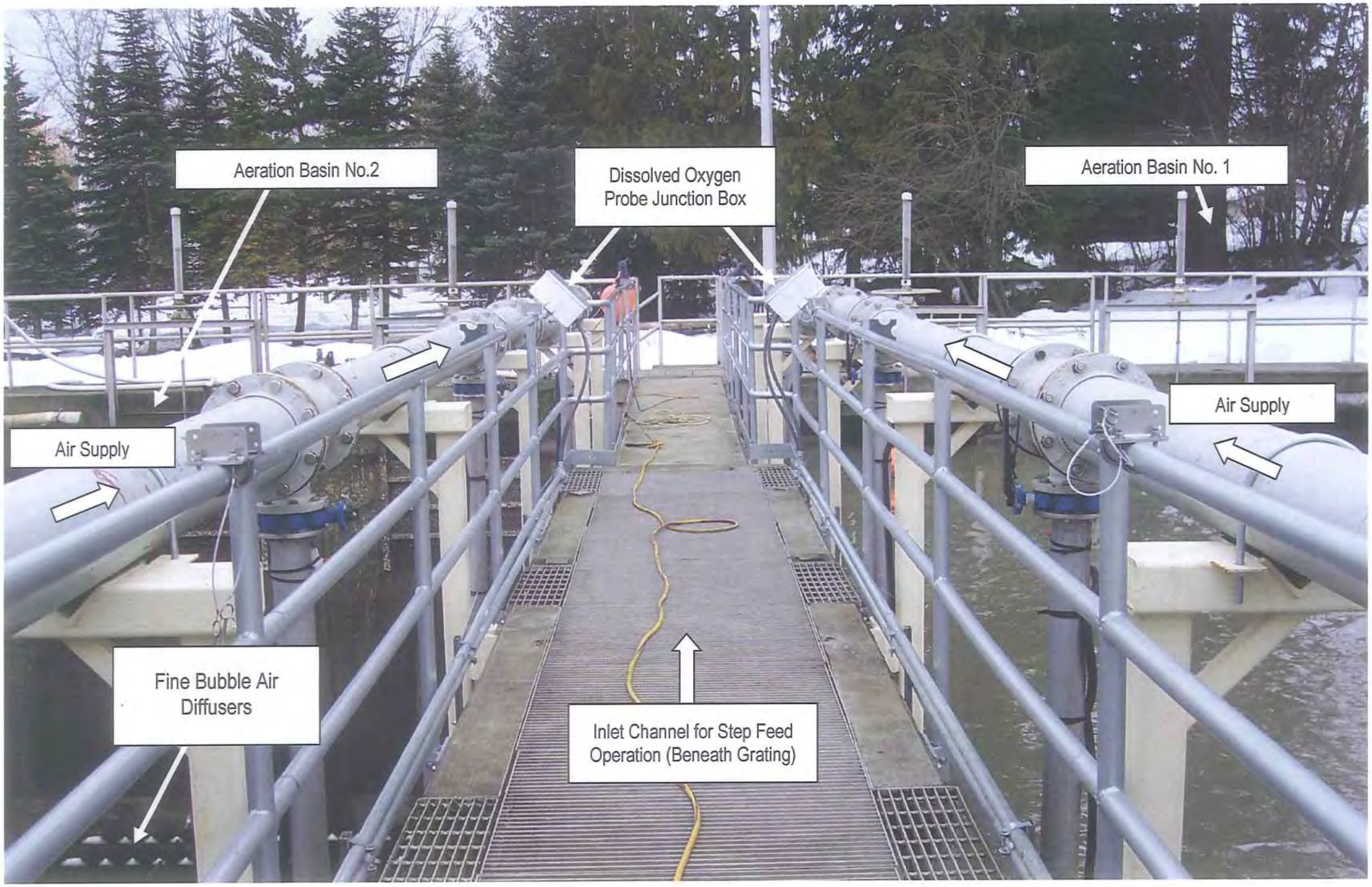
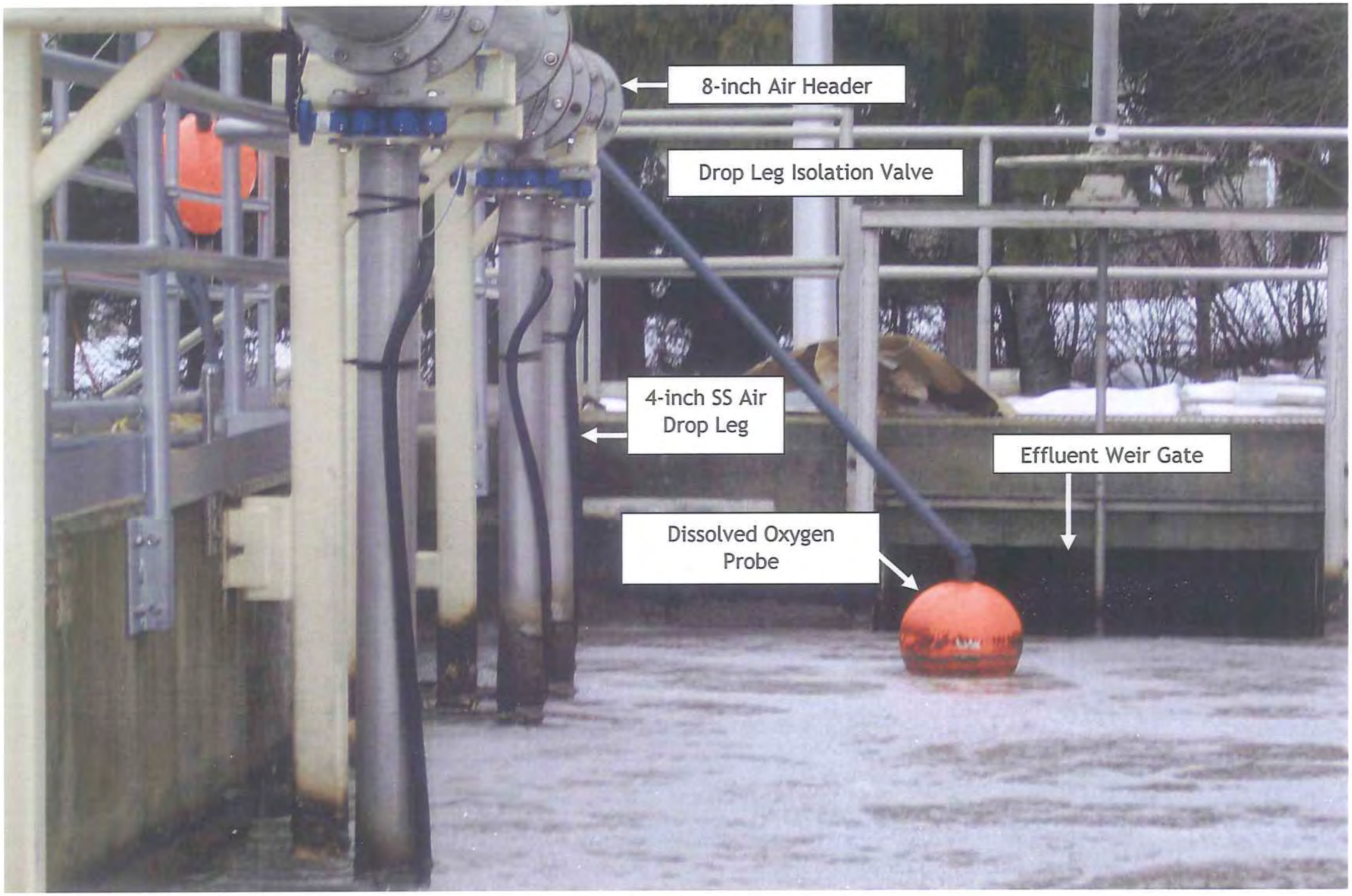


Figure 6-7 – Aeration Basin Diffusers

Figure 6-8 – Dissolved Oxygen Probe



6.5.3 Operation

The design intent of the PD blowers is to operate between 100 percent of full speed and a field defined percentage of full speed (as ambient conditions permit, as low as 18Hz) on a variable frequency drive to allow for energy savings during low oxygen demand periods.

The intent is that the 50 HP PD blower (No. 2) unit will operate as a duty unit with the 100 HP PD blower (No. 1) as a standby unit in the event the 50 HP cannot maintain adequate dissolved oxygen levels in the basins.

- Both the 50 HP and 100 HP PD blowers can be operated individually or concurrently.
- The No. 1 100 HP centrifugal blower <u>must only be operated by itself</u>. It is recommended that the 100 hp centrifugal blower (No. 3) be locked out while the PD blowers are in operation; this will avoid accidentally operating the PD blowers with the centrifugal blower. <u>Operating a centrifugal blower and positive displacement blower concurrently (at the same time) will likely cause damage to the units and result in unsafe operating conditions</u>.

In the event either the No. 1 or No. 2 blower is taken offline for service, the single remaining blower should be able to maintain adequate dissolved oxygen levels during average day conditions.

The actual running speed of the blowers is controlled by the dissolved oxygen levels within the aeration basins and the plant SCADA system. Alternatively, the blower speed may be set manually. Monitoring of the air being delivered to the basins is done by air-flow mass-flow indicator on the blower discharge piping as shown on **Figure 6-3**. See the subsection "Process Performance and Control" for information on maintaining adequate dissolved oxygen and controlling the system.

The maximum flow set point for air being delivered to the basins is 2,100 scfm. This limiting value is hard-programmed into the software such that if one basin is taken off-line, the maximum diffuser flux would be limited to 5 scfm/diffuser to mitigate potential damage to the diffusers due to "over-fluxing." The maximum allowable instantaneous flux through the diffusers is 6 scfm/diffuser.

6.5.4 Normal Operation – Existing Average Conditions

Under normal operating conditions, the 50 hp PD blower (No. 2) is utilized by varying blower speed to provide air for the aeration basins. The remaining 100 hp PD blower (No. 1) is available in AUTO mode as a redundant unit. The 100 hp centrifugal blower (No. 3) should never be used with the PD blowers. Use of PD and centrifugal blowers into the same discharge line may result in damage to the blowers and unsafe operating conditions. It is recommended that the 100 hp centrifugal blower (No. 3) be locked out while the PD blowers are in operation; this will avoid accidentally operating the PD blowers with the centrifugal blower.

6.5.5 Normal Operation – Maximum Month Conditions (with nitrification)

Under Maximum Month operating conditions, the 50 hp PD blower (No. 2) will ramp to full speed, and the 100 hp PD blower (No. 1) will vary speed to provide air for the aeration basins.

6.5.6 Emergency Operation

Under emergency conditions, such as a failure of one of the PD units, the remaining PD unit will automatically start and an alarm condition will be called out.

6.5.7 Use of the 100 HP Centrifugal Blower (No. 1)

In the event of failure of both of the positive displacement blowers, Centrifugal Blower No. 1 will need to be operated in HAND mode. The PD blowers should be locked out at the motor control center to avoid accidentally operating the PD blowers with the centrifugal blower.

Care should be exercised when operating a centrifugal blower since they operate similar to a pump. As the speed is reduced, the discharge volume and pressure are reduced. If the speed is reduced too much, the discharge pressure of the blower may be less than the back pressure in the air line, diffusers, and water pressure in the aeration basin. In such a case, a "surge" condition occurs and can damage the equipment, create unsafe working conditions for the operators, and result in negligible airflow to the aeration basins.

The minimum speed set point was field set at the time of equipment startup using an air-flow mass-flow indicator to keep the blowers from going into a surge condition. The minimum blower speed that causes surge will vary throughout the year and is dependent upon atmospheric conditions (temperature, humidity, and barometric pressure). The operators will need to verify that Blower No. 3 is not automatically dropping to minimum speed on a periodic basis. If so, they will need to increase the minimum speed set point to provide a margin of safety to accommodate varying atmospheric conditions and prevent entering a surge condition.

> ***Note: The minimum blower speed varies with temperature, pressure and humidity. This minimum speed is dictated by the blower design and is the lowest flow the blower can pass before it enters "surge" conditions which can damage, and or destroy the blower. Never operate the blower in surge conditions as it will damage the equipment.***

The isolation valves on the suction piping should remain open unless the operator intends to take the unit off line for maintenance and needs to isolate the unit from the other portions of the system.

6.6 Troubleshooting the PD Blowers

Common symptoms, possible causes, and their cures appear in **Table 6-3** below. Additional troubleshooting tools are available in the manufacturer's O&M information.

Table 6-3 - PD Blower Troubleshooting

	Possible Cause	Remedy
Abnormal noise when running	Too much backlash in the timing gears	Contact KAESER service.
	Bearing play too large	Contact KAESER service.
	Rotors rub against each other	Compare the operating conditions with regard to pressure differential and speed with the machine technical specification.
		Check for dirt in the block and clean if necessary.
Block too hot	Pressure differential too great	Check and correct pressure differential.
	Clogged inlet filter reducing air intake volume	Clean the inlet filter.
	Rotor clearance too large	Contact KAESER service.
Lubricating oil leakage	Oil level too high. Oil leaks from the gas drain.	Drain oil until the level is in the center of the sight glass.
	Oil leaking from around the drive shaft.	Replace the shaft sealing ring.
Reduced air inlet flow	Rotor clearance too large because of wear—probably because of contaminated intake air/gas.	Contact KAESER service.
	Intake resistance too high.	Clean the inlet filter.
Black film on the oil sight glasses	Oil not changed at the correct interval	Change the oil. Clean or renew the sight glass.
	Insufficient oil	Change the oil. Clean or renew the sight glass.
	Oil overheated	Contact KAESER service.
	Blower block overloaded	Contact KAESER service.
Water in the oil	Condensate buildup by prolonged storage and high humidity	Change the oil.
Sound enclosure overheating (if fitted)	Extractor motor defective or turning in the wrong direction	Contact KAESER service.
	Cooling air inlet and/or outlet obstructed	Check that cooling air inlet and outlet are free.
		Check the temperature of the cooling air intake.
	Drive motor overloaded	Check operating conditions.
Other Faults	Drive motor defective. Bearing damage or windings short.	Contact KAESER service.
	Blower block defective	Contact KAESER service.

6.7 Biological Treatment Systems—Process Theory

6.7.1 General

Biological treatment occurs in the aeration basins by creating an active bacteria population to convert incoming wastewater into biomass. The biomass grown and maintained in the aeration basin is then removed from the mixed liquor by the secondary clarifier and returned by the RAS pumps in the Control Building to the headworks (downstream of the grit channel). The RAS serves to maintain a high concentration of bacteria in the basin. However, wasting excess biomass must occur to maintain a balance in the aeration system and to dispose of old biomass.

The design of the biological treatment system for the Sandpoint WWTP is for removal of the following biological constituents typically reported as:

- Biochemical oxygen demand (BOD)
- Total suspended solids (TSS)
- Ammonia as (N)

Phosphorus removal is currently not required for Sandpoint and is not expected to be a permit condition in the near term. The following sections discuss aerobic treatment theory as it applies to the Sandpoint aeration basins. The aeration manufacturer also has general descriptions and explanations in their O&M literature.

6.7.2 Pollutant Removal

The biological treatment processes utilized in Sandpoint makes use of aerobic bacteria, which functions only in the presence of aerobic dissolved oxygen (DO).

1. **Biochemical Oxygen Demand (BOD):** Dissolved and finely suspended organic oxygen demanding substances are measured as the 5-day biochemical oxygen demand (BOD_5 or BOD). The biological microorganisms absorb this food source, which consists of carbohydrates, proteins, and fats. They subsequently oxidize the food source with atmospheric oxygen in solution as dissolved oxygen (DO), to carbon dioxide (CO_2), and water (H_20). This process provides energy for respiration and growth of new microorganisms. Microorganisms that predominate in a biological treatment system, including the suspended growth system of activated sludge, are those that efficiently remove the food and convert it to energy and additional organisms. Since oxygen is available, aerobic bacteria species dominate.

   In an activated sludge system, the organisms are fed raw wastewater, then retained for a time adequate to partially or fully break the organics down aerobically into CO_2 and H_20. The bacteria are referred to as "mixed liquor." In a suspended growth, activated sludge system, the mixed liquor is then discharged to a clarifier where the organisms are separated from the water by gravity sedimentation. The microorganisms are then pumped back to the aeration basin for mixing with the raw sewage (food source) and aeration. This recirculation stream is the RAS. The organisms that consume BOD in an aerobic system reproduce rapidly and the sludge age (solids retention time, SRT, or mean cell retention time, MCRT) must be controlled to maintain their population and viability.

Excess microorganisms grown in the activated sludge under aerobic conditions can equal 50 to 75 percent or more of the mass of influent BOD. To maintain a balance in the system, excess organisms are periodically "wasted" from the system as waste activated sludge (WAS). Some RAS is diverted to wasting, thereby becoming the WAS. WAS then undergoes further digestion and trucking to disposal off site.

2. **Total Suspended Solids (TSS):** Total suspended solids consist of material in the sewage that is not removed by screening or grit removal but is retained on a glass fiber filter. This material has both inert (non-degradable) and biodegradable fractions. The TSS that pass into the aeration basins is also partially absorbed by the microorganisms as a food source and/or flocculated by attachment to the microorganisms for removal by sedimentation in the clarifiers. Settled solids are either returned to the basin as RAS or wasted as WAS.

3. **Ammonia:** Ammonia is a common wastewater constituent. Sandpoint is not required by their NPDES Permit to perform ammonia removal. Additional oxygen is required for the nitrification process.

   Nitrogen from ammonia is initially incorporated into the cell structure of the microorganisms as they grow and multiply. Normal nitrogen content of the biomass is approximately 8 percent on a dry solids basis. Nitrogen is an essential nutrient for healthy cell growth, and nitrogen in the ammonia form is the preferred source for the microorganisms. Next, microorganisms capable of "nitrification" convert ammonia nitrogen (NH_3-N) to nitrite and nitrate nitrogen (NO_2-N and NO_3-N) by biological oxidation. This process uses dissolved oxygen in the aeration basin as the electron acceptor.

   It should be noted that at a DO level less than 1.0 mg/L, nitrification slows or ceases because oxygen becomes a limiting constituent in the conversion process. This can cause excess formation of NO_2, which interferes with chlorination and pathogen kill. Therefore, the DO levels should be maintained at 2.0 mg/L or higher.

   Organisms capable of nitrification are not usually the same organisms that oxidize organics (BOD), and specific conditions must be present in the system before nitrification occurs. Nitrifying bacteria grow (reproduce) more slowly than the organisms that use BOD as a substrate since ammonia conversion to nitrites and nitrates yields much less energy. Therefore, long sludge ages tend to favor nitrifiers. Given the typically longer sludge ages in aeration basins, the growth of nitrifiers is not uncommon. Temperature also affects nitrification; therefore, during warmer periods, nitrification will occur at lower sludge ages and increase the oxygen demand.

4. **Phosphorus:** Phosphorus is a common wastewater constituent and is also necessary for healthy cell growth. Currently, Sandpoint is not required by the NPDES Permit to perform phosphorus removal. The facilities are not designed for phosphorus removal.

6.7.3 Biological (Sludge) Growth

Biological organisms use the organics in wastewater as food for sustaining the biomass by respiration and for synthesis of new cell growth. Cells create energy by oxidizing available organics with oxygen, which is supplied by the blowers and diffusers to the mixed liquor in the aeration basins. The ratio of biomass created versus consumed BOD is known as the yield rate and is typically 0.65 to 0.75. The other 0.25 to 0.35 of the BOD is consumed as energy for cell maintenance.

The cell growth is partially offset by die off and respiration losses in cell mass known as "endogenous respiration." The degree of endogenous respiration is proportional to the length of time that the solids retained in the system as quantified by the SRT. The endogenous respiration rate is also temperature dependent, increasing with increased temperature.

Generally, SRT is the ratio of solids in the aerobic basins to the solids wasted per day. Because organism growth generally occurs only under aerobic conditions, the SRT considers the amount of organisms in the aeration basin and does not include the organism mass in the clarifiers. Calculate SRT as follows:

Equation 6.7.3A

$$SRT = \frac{V_r \times MLVSS}{(Q - Q_w) \times X_w + (Q_w \times X_w)}$$

Where:

SRT	=	Solids residence time, in days
V_r	=	Combined volume of the aeration basin in use
MLVSS	=	Mixed liquor volatile suspended solids in the aeration basin, in mg/L.
Q_w	=	Flow rate of wasted biosolids, in mgd. Note: multiply gpm by 0.00144 to get mgd
X_w	=	Concentration of waste solids, in mg/L
Q_e	=	Effluent flow rate, in mgd.
X_e	=	Concentration of solids leaving the secondary clarifier in the clarified effluent, in mg/L.

Utilize the above equation to evaluate the actual operating SRT of a system based on easily measured parameters.

Net biomass growth is a result of the product of the cell yield and the BOD removed, minus the endogenous respiration rate, times the mass of cells in the biological treatment system, plus a portion of the influent TSS, as follows:

Equation 6.7.3B

$$NetSludgeGrowth = Y \times BOD_r - k_d \times V \times X \times 8.34 + (1 - d) \times TSS_o$$

Where:

Y	=	yield coefficient, typically 0.65 to 0.75
BOD_r	=	Pounds of BOD removed per day = $Q(BOD_{in} - BOD_{out})$ 8.34
Q	=	Influent flow rate, in mgd
BOD_{in}	=	Influent BOD from the primary clarifiers, in mg/L
BOD_{out}	=	Effluent BOD, in mg/L
k_d	=	Endogenous respiration rate, varies with temperature, with typical values between 0.025 and 0.075 day^{-1}
V	=	Combined volume of the aeration basin in use = 0.60 Mgal for each basin, in Mgal
MLSS	=	Mixed liquor suspended solids concentration in aeration, in mg/L
d	=	Reduction in TSS resulting from biological treatment and clarification with a typical range of 0.3 to 0.5.
TSS_0	=	Influent TSS, in mg/L

Based on the above typical values, expectation of new sludge growth in the biological treatment system will be approximately 0.85 to 1.0 times the BOD from the primary clarifiers.

6.7.4 Nitrification

Microorganisms accomplish nitrification by oxidizing ammonia nitrogen (NH_3-N) first to nitrite nitrogen (NO_2-N) and secondly to nitrate nitrogen (NO_3-N). Oxidation by microorganisms under aerobic conditions in the aeration basin is expected to occur consistently, however will occur most readily during warmer periods. Organisms that accomplish nitrogen oxidation experience slower growth regeneration than organisms that are capable of removing BOD alone. For example, the generation time for nitrification organisms under standard temperature conditions (20° C) and no environmental limitations is expected to be 2 to 4 days, as opposed to less than one day for organisms capable of BOD removal under aerobic conditions. Consequently, if the sludge age in the facility (solids residence time, SRT, or mean call residence time, MCRT) approaches this level, nitrification may occur. Under decreased temperatures, typically experienced during winter conditions, the generation time for these organisms is much longer; for example, at approximately 10°C the generation time may be 8-20 days.

> ***<u>NOTE</u>: Any adjustments to SRT should be made slowly to avoid system upsets. Allow 3 to 7 days for the plant to stabilize per day of SRT change (i.e., for a change in SRT from 5 days to 10 days, increase SRT by 1 to 2 days per week). The Operator will need to monitor plant performance to determine the actual rate of change.***

Ammonia nitrogen and organic nitrogen are present in the raw sewage. Organic nitrogen is hydrolyzed to ammonia nitrogen by destruction of the organic molecules to which the organic nitrogen is attached. This is done by the aerobic organisms when they remove the BOD associated with the organic molecules and consume it as a food source. Then the nitrifying bacteria can use the energy derived from the BOD removal and energy from the nitrification reaction to oxidize the ammonia nitrogen to nitrate.

Nitrification proceeds approximately according to the following reactions:

Equation 6.7.4A

$$NH_4^+ + 1.5O_2 \rightarrow NO_2^- + H_2O + 2H^+ \quad \text{ammonia oxidation to nitrite}$$

$$NO_2^- + 0.5O_2 \rightarrow NO_3^- \quad \text{nitrite oxidation to nitrate}$$

$$NH_4^- + 2.0O_2 \rightarrow NO_3^- + H_2O + 2H^+ \quad \text{overall reaction}$$

Where:

NH_4^+	=	Ammonium ion (ammonia in aqueous solution)
O_2	=	Atmospheric oxygen (dissolved oxygen in aeration basin)
H_20	=	Water
H^+	=	Hydrogen ion (acid radical)
NO_2^-	=	Nitrite ion
NO_3^-	=	Nitrate ion

The O_2 required is dissolved oxygen (DO) removed from the mixed liquor, which is supplied by the blowers and diffusers in the aeration basins. Note that for every pound of ammonia removed, approximately 4.6 pounds of oxygen are required. This high amount of oxygen uptake may severely impact the basin DO levels and result in anoxic or anaerobic conditions. The operators should monitor DO levels, incoming waste streams, ammonia levels, and temperatures to understand and better react to the biological treatment variations.

The hydrogen ion generated is an acid radical ion which, following its generation in the nitrification process, combines with bicarbonate ions in the mixed liquor and thus reduces the alkalinity:

Equation 6.7.4B $$H^+ + HCO_3^- \rightarrow H_2CO_3 \rightarrow CO_2(g) + H_2O$$

Where:

H^+	=	Hydrogen ion (acid radical)
HCO_3^-	=	Bicarbonate ion
H_2CO_3	=	Carbonic acid (un-disassociated)
$CO_2(g)$	=	Carbon dioxide (gas)
H_2O	=	Water

This may reduce the pH in the mixed liquor if too much alkalinity is consumed. The pH is not expected to be reduced enough to affect biological treatment, since adequate buffer in the form of the bicarbonate ion is generally present in wastewater. If alkalinity is limiting, pH may be reduced excessively and inhibit further biological organism efficiency at removing BOD and/or ammonia. Consequently, it is necessary to monitor alkalinity in the treated effluent regularly to verify that biological inhibition does not occur. <u>Alkalinity should be maintained at 50 mg/L or above.</u>

<u>DO should be maintained at a minimum of 1.5 to 3.0 mg/L</u> to assure adequate oxygen is available for nitrification. Lowering the DO to 1.0 mg/L will result in significantly reducing or ceasing nitrification.

The biological treatment system is not configured or optimized for subsequent denitrification to remove nitrates from the wastewater. Additional processes and controls are necessary to accomplish this.

6.7.5 Oxygen Requirement for Biological Treatment

Adequate oxygen must be available in the aeration basin for oxidation of the BOD by the organisms for energy generation, synthesis of additional organisms, endogenous respiration, and for oxidation of ammonia nitrogen to nitrate (if nitrification is required). Empirical studies have indicated that maintaining a residual of approximately 1.5 to 2.0 mg/L of dissolved oxygen in the aeration basin is necessary to provide adequate oxygen for the biological organisms to reduce BOD and nitrify efficiently. The dissolved oxygen is provided by the blowers and diffusers.

Total oxygen requirements of the system consist of the following:

Equation 6.7.5A $O_2 req'd = a \times BOD_R + b \times k_d \times V \times MLSS \times 8.34 + 4.6 \times NH_{3R}$

Where:

O_2 req'd	=	Oxygen required (total)
a	=	Oxygen required per pound of BOD removed, approximately 0.6
BOD_R	=	BOD removed, lb/day
b	=	O_2 required per pound of volatile suspended solids (VSS) during endogenous respiration, approximately 1.25
k_d	=	Endogenous respiration rate coefficient, day^{-1}, typically 0.025 to 0.075
V	=	Combined volume of the aeration basins in use, in Mgal
MLSS	=	Mixed liquor suspended solids concentration in aeration, in mg/L
8.34	=	Conversion factor to obtain lb/day
4.6	=	Pounds of O_2 required per pound of NH_3 oxidized
NH_{3R}	=	Ammonia oxidized or removed, in lb/day

A simplified expression is also available with similar results. The following equation combines BOD conversion and endogenous respiration into a common term. The simplified equation is:

Equation 6.7.5B $O_2 req'd = 1.4 \times BOD_R + 4.6 \times NH_{3R}$

Where: The definitions from the previous equation apply

Table 6-4 presents the oxygen transfer requirements at each loading condition. The loading requirements have been broken into BOD and NH_3. If nitrification is required, adequate oxygen must be transferred to accommodate both components. The oxygen demand will vary with influent BOD and ammonia levels in addition to the influent flow. During extreme flow events, a portion of the influent will be treated with peak flow handling systems (e.g., stormwater clarifier, primary clarifiers), and the remaining flow and associated load will reach the aeration basins. If peak organic loads occur during low flow periods, a greater percentage of the load will reach the aeration basins.

Table 6-4 - Oxygen Requirements for Design Organic Loads [1]

Parameter	Ex Ave	Maximum Month Flow Maximum Month Load	Average Flow Average Load	Maximum Month Flow Average Load	Average Flow Maximum Month Load	Average Flow Peak Day Load
BOD (lb O_2/day	2,256	3,774	4,008	2,802	5,451	13,227
NH3 (lb O_2/day)	762	4,410	2,500	3,940	3,750	3,750
TOTAL (lb O_2/day)	3,018	8,184	6,508	5,742	9,208	16,977

[1] *Pounds of oxygen at standard conditions*

To achieve these transfer oxygen amounts, one must account for interferences from the wastewater, temperature effects, atmospheric conditions, saturated DO levels possible in wastewater, and desired or target DO level. The manufacturer has provided standard oxygen transfer values with the equipment, but standard values are based on clean water at 20° C and standard atmospheric conditions (14.7 psi). The following equation is used to correct the standard data to actual conditions:

Equation 6.7.5C

$$AOTR = SOTR \frac{\beta \times C_S - C_w}{C_{S20}} \times \theta^{T-20} \times \alpha$$

Where:

AOTR	=	Actual oxygen transfer rate, in lb O_2/day (or lb O_2/hour).
SOTR	=	Standard oxygen transfer rate from manufacturer's literature, in lb O_2/day (or lb O_2/hour).
β	=	Correction factor to account for wastewater constituents such as salts, particulates, and surface active substances. Typical ranges are 0.70 to 0.98, with a value of 0.98 used at Sandpoint.
C_S	=	Oxygen saturation concentration for clean water at field operating conditions, in mg/L.
C_W	=	Desired or target DO level in the aeration basin, in mg/L. Typically this is 2.0 mg/L.
C_{S20}	=	Oxygen saturation concentration for clean water at 20° C and standard atmospheric conditions, in mg/L.
θ	=	Temperature correction factor. Typical ranges are 1.015 to 1.040, with a value of 1.024 commonly used.
T	=	Actual temperature of aeration basin contents in degrees C.
α	=	Correction factor to account for tank mixing and geometry. Typical ranges are 0.6 to 1.2 for mechanical aeration equipment. A value of 0.7 was used at Sandpoint.

6.8 Dissolved Oxygen Control

The amount of oxygen required is a function of the BOD, MLSS, degree of nitrification, and temperature, as discussed in the preceding sections of this chapter. Since the oxygen requirements vary throughout the day and year, the blowers are variable speed units, thereby allowing reduced energy consumption during periods when oxygen demand is at a reduced level.

Each aeration basin contains a dissolved oxygen probe to assist with process monitoring and control. Mounting points for each probe are available at three points along the length of each basin. **Figures 6-6** and **6-8** show the dissolved oxygen probes and their mounting locations. Control programming allows for averaging of the D.O. level from each basin as well as operator selection for the primary D.O. probe. The normal D.O. set point for the basin is based on overall process control considerations and will likely range from 1.5 to 3.0 mg/L.

Probable oxygen demand, assuming a MLSS temperature of 15° C, is included in **Table 6-4.** To satisfy the varying oxygen demands, the blowers have variable frequency drives (VFDs) that are controlled by the PLC. The PLC operates according to the following:

- Automatic control of the blower VFDs based on dissolved oxygen probe signal

- Operator adjustable dissolved oxygen set point

Based on **Table 6-4,** recommended operation for the aeration basins and blowers are:

- Maintain a DO level between 1.5 and 3.0 mg/L. To reduce energy consumption further, operating near 1.0 mg/L between 11:00 p.m. and 6:00 a.m. may result in additional cost savings. This period also generally has fewer flow and load fluctuations; therefore, system disruptions should be minor.
- Increased blower speed will be necessary during elevated loading. Higher than average loading may occur daily in the afternoon due to higher temperatures or increased flows. This condition will become more prevalent as average loading to the WWTP increases.

6.9 Typical Operating Parameters

The preceding sections discussed the biological aspects of the aeration basin process and control of oxygen transfer. An understanding of other typical operating parameters will assist the operator in achieving pollutant removal throughout the entire plant. For example, the operator must control the amount of RAS and WAS to maintain a viable cell mass in the aeration basins, thereby maintaining efficient BOD removal and solids removal in the clarifier. **Table 6-5** lists typical parameters applicable to aeration basins and likely ranges for this facility. The ranges are a guideline for a complete mix activated sludge system like this facility. Optimum performance for this facility will likely vary from that shown. Seasonal variations to maintain optimum performance are also likely.

Table 6-5 - Typical Aeration Basin Operating Parameters [a]

Parameter	Value	
Solids Residence Time (SRT)	1 – 10	days
Food to Microorganism Ratio (F/M)	0.2 – 1.0	lb BOD_5/lb MLVSS·day
Organic Loading	50 – 120	lb BOD_5/1,000 ft^3·day
Mixed Liquor Suspended Solids (MLSS)	1,000 – 3,000	mg/L
Hydraulic Residence Time	3 – 12	hours
Recycle Ratio $\left(\frac{Q_{RAS}}{Q}\right)$	0.25 – 1.0	
Dissolved Oxygen (DO)	1.5 – 2.0	mg/L

[a] *Adapted from Metcalf & Eddy (3rd Edition) Table 10-5.*

The parameters listed in **Table 6-5** can generally be defined as follows:

- **Solids Residence Time (SRT):** The SRT is the average sludge age in the aeration basin and reflects the amount of biosolids wasted versus the amount of volatile biosolids in the reactor.
- **Food to Microorganism Ratio (F:M):** The F:M ratio is a ratio of the incoming BOD to the volatile biomass in the reactor.

- **Organic Loading:** Organic loading reflects the amount of BOD introduced into the reactor.
- **Mixed Liquor Suspended Solids (MLSS):** MLSS is a measure of the biomass in the reactor. If this is too high, the bacteria starve which hampers settling. If too low, the biomass may not be able to react to incoming waste properly.
- **Hydraulic Residence Time (HRT):** HRT is the theoretical time that the incoming waste spends in the reactor. To determine the HRT, divide the basin volume by the influent flow. If the volume is in Mgal and the flow is in mgd, the resulting value is days.
- **Recycle Ratio:** The recycle ratio reflects the flow of biomass back to the basin as RAS, relative to the influent flow to the WWTP.
- **Dissolved Oxygen (DO):** Maintain the DO concentration in the aeration basin in the range of 1.0 to 2.0 mg/l at all times. In order to obtain and/or maintain the proper DO level, the operator should program the Programmable Controller to adjust the effluent weir at the aeration basin to obtain the water level in the basin that will provide the desired aeration rate. The water level in the aeration basin will increase and decrease automatically according to the time of day and flow into the basin. In this way, aeration of the wastewater is automatically increased and decreased to meet the aeration requirements of the flow entering the basin. Through experimentation, the operator will be able to determine the weir settings, which provide the proper DO level in the aeration basin at all times. Avoid on-off operation of the aerators eventually reducing the design life since it is based on continuous operation.

6.10 Activated Sludge Process Monitoring Methods

One of three common methods may accomplish activated sludge process control. Selection of which method to use the operator's choice and should be based on experience, reliability, confidence, staffing, and a number of other factors. Regardless of the control strategy employed, it is recommended that the operators average lab results from the preceding three to seven days to determine an overall trend in the process. Modifying operating procedures based on a single day's sample may result in over-correction, leading to widely varying process variables and treatment plant performance.

6.10.1 F:M Ratio

The F:M ratio is defined as the pounds of BOD_5 in the plant influent in a 24-hour period divided by the pounds of microorganisms in the aeration basin.

Equation 6.10.1 $$F:M = \frac{lbsBOD}{lbsMLSS} = \frac{Q \times BOD_{influent}}{V \times MLSS}$$

Where:

Q	=	Average daily flow (mgd)
$BOD_{influent}$	=	5-day BOD_5 in the influent wastewater (mg/l)
V_r	=	Volume of aeration basin (MG)
MLSS	=	Concentration of mixed liquor suspended solids under aeration (mg/l)

Some authorities express the F:M ratio in terms of mixed liquor volatile suspended solids (MLVSS) rather than MLSS. Because of this, carefully evaluate data found in literature to determine the method of calculation used by a particular author.

The F:M ratio directly relates the net cell growth (i.e., sludge production), degree of stabilization, and the ability of the activated sludge to settle and produce a good quality effluent. Note the sludge production decreases and the degree of stabilization increases as the F:M ratio decreases.

Controlling the quantity of microorganisms (MLSS) in the aeration basin can maintain the F:M ratio at the desired level. Of course, it will not be possible to control the quantity of food entering the basin, but in general, this value should be nearly constant in a day-to-day basis. By knowing the desired F:M ratio, the operator may determine the optimum quantity of microorganisms (MLSS).

Controlling the quantity of sludge (RAS) returned to the aeration basin can also maintain desired F:M ratio. To increase the quantity of MLSS in the aeration basin, return more sludge (which decreases the F:M ratio). To decrease the MLSS concentration, return less sludge (which increases the F:M ratio).

6.10.2 Solids Residence Time (SRT) or Mean Cell Residence Time (MCRT)

SRT is the theoretical number of days that the activated sludge organisms are under aeration before being wasted from the process and is referred to as the solids retention time (SRT) and the sludge age. The SRT is directly related to the F:M ratio, net cell growth (i.e., sludge production), degree of stabilization, and the ability of the activated sludge to settle and produce a good quality effluent. Note the sludge production decreases and the degree of stabilization increases as the SRT increases.

The SRT is equal to the quantity of MLSS in the aeration basin divided by the quantity of sludge intentionally wasted (WAS) and unintentionally lost in the secondary effluent. Refer to Equation 6.7.3A to calculate the SRT.

The efficiency of clarification is generally a function of the sludge age or the average time the biological solids remain in the treatment process before discarded in the waste activated sludge. This is because the types of organisms present in the mixed liquor dependant on the time solids retain within the system. In general, a young sludge has a relatively high proportion of filamentous organisms. These filamentous organisms form long thread-like colonies tending to bind the biological floc together. In a young sludge the overabundance of these threads results in the formation of a slow settling sludge. Young sludge, which is not fully developed, may also form small fluffy “straggler” floc. Old sludge is generally over-oxidized and the solids form into very compact granular floc, referred to as “pin” floc or “ash”. This type of floc tends to settle slowly and to displace easier by velocity currents within the clarifier.

6.10.3 Mixed Liquor Suspended Solids (MLSS)

In this control method, a constant MLSS value is maintained. Assuming biological loading and influent flows remain constant, this method will produce exactly the same results as either the F:M or MCRT method; flows and loading, however, usually have some variation. As long as the variations are not excessive, this method should produce effective results.

Alternative MLSS Test Procedure

Traditionally, the number of microorganisms contained in the mixed liquor has-been expressed in terms of the MLSS concentration in milligrams per liter (mg/l) and should be in the range of 1,000 to 3,000 mg/l. However, due to the relatively excessive time and effort required to complete a MLSS test, the simpler centrifuge spin test is now generally preferred for use in solids control. The centrifugal spin test defines solids level in terms of percent solids by volume. This test relies on establishing a correlation between the MLSS test and centrifuge spin test.

6.11 Troubleshooting Guidance

Table 6-6 is a synopsis of several common problems that occur in activated sludge aeration basins and a cursory list of potential remedies. Careful observation and record keeping of plant process parameters discussed in this chapter are crucial to obtaining proper treatment. As discussed previously, minimize changes to process parameters over several sludge ages to allow the process to come to equilibrium with the new conditions. Additionally, it is suggested that modifications to the process be limited to one or two adjustments at a time. This limits the potential for over-correction while providing a clearer cause-effect relationship for process control.

Table 6-6, taken from the EPA document titled *Performance Evaluation and Troubleshooting at Municipal Wastewater Treatment Facilities*, provides a summary of common operating problems, including excessive filamentous growth, and potential steps to cure the problem. A common process problem at the Sandpoint facility is excessive filamentous bacteria in the MLSS. The cause of filamentous growth may include one or more of the following:

- Widely varying organic loading
- Variations in flow, resulting in varying a HRT
- Low DO levels
- Improper pH (i.e., either too low or widely varying)
- Temperatures (e.g., during summer)
- Nutrient deficiency – this may occur with industrial discharges having a high BOD to nitrogen or phosphorus ratio
- Nature of the waste (e.g., industrial wastes or toxic components)
- High influent sulfide concentrations that promote the growth of Thiothrix, a filamentous bacteria
- Very low F:M

Some additional references that may be of value to the operator are:

- *Basic Activated Sludge Process Control*, Water Environment Federation, 1994
- *MANUAL on the Causes and Control of Activated Sludge Bulking, Foaming, and Other Solids Separation Problems*, Third Edition, Jenkins et al., 2004
- *Operation of Municipal Wastewater Treatment Plants - Manual of Practice*, Volumes I - III, Fifth Edition, Water Environment Federation, 1996
- *Performance Evaluation and Troubleshooting at Municipal Wastewater Treatment Facilities*, EPA 430/9-78-001

Table 6-6 - Troubleshooting Guide

Activated Sludge

INDICATORS/OBSERVATIONS	PROBABLE CAUSE	CHECK OR MONITOR	SOLUTIONS
1. Sludge floating to surface of secondary clarifiers.	1a. Filamentous organisms predominating in mixed liquor ("bulking sludge")	1a. SVI[1] - if less than 100, 1(a) is not likely cause; microscopic examination also can be used to determine presence of filamentous organisms.	1a. (1) Increase DO in aeration tank if less than 1 mg/1 (2) Increase pH to 7 (3) Supplement deficiency of nutrients so that BOD to nutrient ratio is no more than 100 mg/1 BOD to 5 mg/1 total nitrogen; to 1 mg/1 phosphorus; to 0.5 mg/1 iron (4) Add 5-60 mg/1 of chlorine to return sludge until SVI <150 (5) Add 50-200 mg/1 of hydrogen peroxide to aeration tank until SVI <150 (6) Increase SRT (7) Increase sludge return rate
	1b. Denitrification occurring in secondary clarifiers; nitrogen gas bubbles attaching to sludge particles; sludge rises in clumps	1b. Nitrate concentration in clarifier influent; if no measureable NO_3, than 1(b) is not the cause	1b. (1) Increase sludge return rate (2) Increase DO in aeration tank (3) Reduce SRT
2. Pin floc in secondary clarifier overflow - SVI is good but effluent is turbid	2a. Excessive turbulence in aeration tanks	2a. DO in aeration tank	2a. Reduce aeration agitation
	2b. Overoxidized sludge	2b. Sludge appearance	2b. Increase sludge wasting to decrease SRT
	2c. Anaerobic conditions in aeration tank	2c. DO in aeration tank	2c. Increase DO in aeration tank
	2d. Toxic shock load	2d. Microscopically examine sludge for inactive protozoa	2d. Re-seed sludge with sludge from another plant if possible; enforce industrial waste ordinances

Troubleshooting Guide (cont)

Activated Sludge

INDICATORS/OBSERVATIONS	PROBABLE CAUSE	CHECK OR MONITOR	SOLUTIONS
3. Very stable dark tan foam on aeration tanks which sprays cannot break up	3a. SRT is too long	3a. If SRT greater than 9 days, this is probable cause	3a. Increase sludge wasting so as to reduce SRT
4. Thick billows of white sudsy foam on aeration tank.	4a. MLSS too low	4a. MLSS	4a. Decrease sludge wasting so as to increase MLSS
5. Aerator contents turn dark-sludge blanket lost in secondary clarifier	5a. Inadequate aeration	5a. Aeration basin DO	5a. (1) Increase aeration by placing another blower in service (2) Decrease loading by placing another aeration basin in service (3) Check aeration system piping for leaks (4) Clean any plugged diffusers
6. MLSS concentrations differ substantially from one aeration basin to another	6a. Unequal flow distribution to aeration	6a. Flow to each basin	6a. Adjust values and/or inlet gates to equally distribute flow
7. Sludge blanket overflowing secondary clarifier weirs uniformly throughout basin	7a. Inadequate rate of sludge return	7a. Sludge return pump output	7a. (1) If return pump is malfunctioning, place another pump in service & repair (2) If pump is in good condition increase rate of return and monitor sludge blanket depth routinely. Maintain 1-3 foot deep blanket. When blanket increases in depth, increase rate of return (3) Clean sludge return line if plugged

Troubleshooting Guide (cont)

Activated Sludge

INDICATORS/OBSERVATIONS	PROBABLE CAUSE	CHECK OR MONITOR	SOLUTIONS
	7b. Unequal flow distribution to clarifiers causing hydraulic overload.	7b. Flow to each clarifier.	7b. Adjust valves and/or inlet gates to equally distribute flow.
	7c. Peak flows are overloading clarifiers.	7c. Hydraulic overflow rates at peak flows if >1,000 gpd/sq ft, this is a likely cause.	7c. Install flow equalization facilities or expand plant.
	7d. Solids loadings are too high on clarifier.	7d. Loadings should not exceed 1.25 lb/sq ft/hr.	7d. Reduce MLSS concentration by increased wasting.
8. Sludge blanket overflowing secondary clarifier weirs in one portion of clarifier.	8a. Unequal flow distribution in clarifier.	8a. Effluent weir.	8a. Level effluent weirs.
9. In diffused aeration basin, air rising in very large bubbles or clumps in some areas.	9a. Diffusers plugged.	9a. Visual inspection.	9a. Clean or replace diffusers Check air supply-install air cleaners ahead of blowers to reduce plugging from dirty air.
10. pH of mixed liquor decreases to 6.7 or lower. Sludge becomes less dense.	10a. Nitrification occurring and wastewater alkalinity is low.	10a. Effluent NH_3; influent and effluent alkalinity.	10a. (1) Decrease sludge age by increased wasting if nitrification not required. (2) Add source of alkalinity - lime or sodium bicarbonate.
	10b. Acid wastewater entering system.	10b. Influent pH	10b. Determine source and stop flow into system.

Troubleshooting Guide (cont)

Activated Sludge

INDICATORS/OBSERVATIONS	PROBABLE CAUSE	CHECK OR MONITOR	SOLUTIONS
11. Sludge concentration in return sludge is low (<8,000 mg/l)	11a. Sludge return rate too high.	11a. Return sludge concentration, solids balance around final clarifier, settleability test.	11a. Reduce sludge return rate.
	11b. Filamentous growth.	11b. Microscopic examination, DO, pH, nitrogen concentration.	11b. Raise DO, raise pH, supplement nitrogen, add chlorine. (see item 1).
	11c. Actinomycetes predominates.	11c. Microscopic examination, dissolved iron content.	11c. Supplement iron feed if dissolved iron less than 5 mg/l.
12. Dead spots in aeration tank.	12a Diffusers plugged.	12a. Visual inspection.	12a. Clean or replace diffusers - check air supply - install air cleaners ahead of blowers to reduce plugging from dirty air.
	12b. Underaeration resulting in low DO.	12b. Check DO and RAS rate.	12b. Increase rate of aeration to bring DO concentration up to 1 to 3 mg/l.

Chapter 7

Secondary Clarification and RAS Pumping

Chapter 7 – Secondary Clarification and RAS Pumping

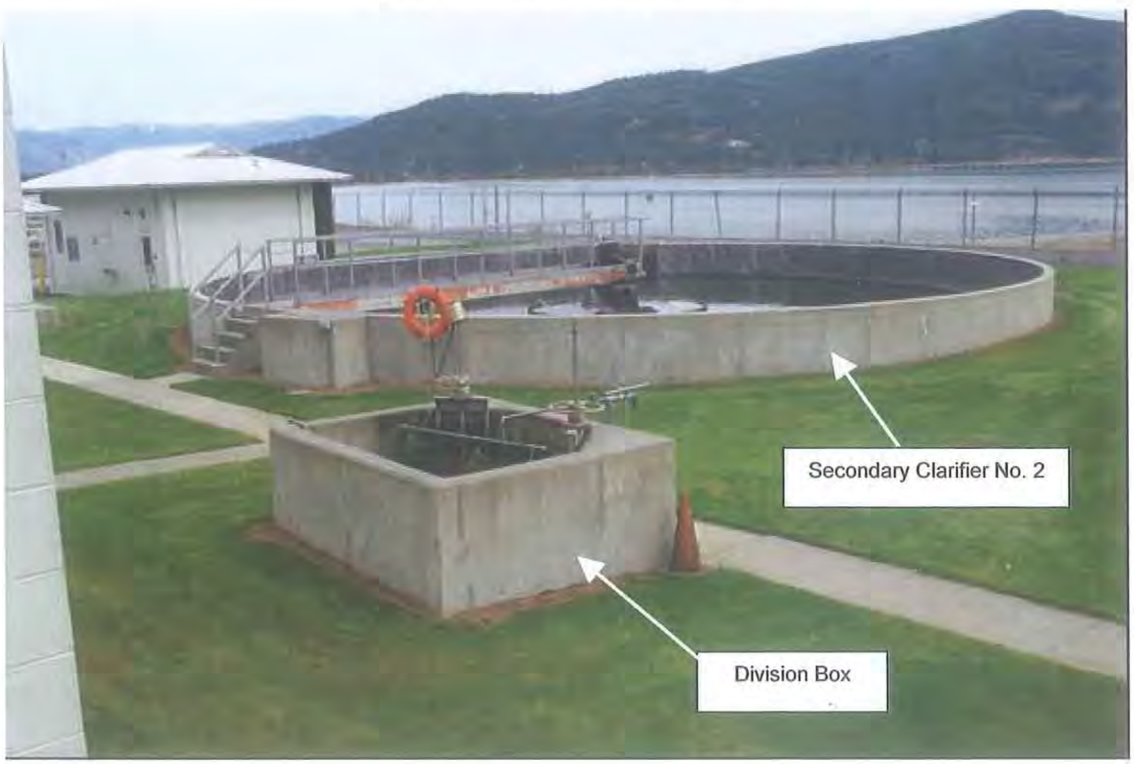
7.1 General

Immediately following biological treatment in the aeration basins, MLSS discharges through one of the effluent weirs to the secondary clarifier. The secondary clarifiers provide a quiescent zone for MLSS settling and thickening, resulting in clarified effluent for subsequent disinfection in the Chlorine Contact Chamber. Solids pulled from the clarifier underflow is pumped by the return activated sludge (RAS) pumping system back to the influent line to the aeration basins. The secondary clarifier and RAS pumping system (originally constructed in approximately 1974) was not modified during the 2008-2010 improvements. Attention is directed to the 1974 drawings and O&M information for further information.

7.2 Component Description

Two 55-foot-diameter secondary clarifiers were originally constructed for use with the filter tower and were converted to use with the aeration basins as activated sludge clarifiers. Both clarifiers are used under normal operating conditions. The clarifier mechanisms employ rapid sludge withdrawal for RAS. Because rapid sludge withdrawal is not normally used with filter tower treatment, these mechanisms appear to be new with the activated sludge system. A photo of one secondary clarifier and the division box is included on Figure 7.1.

Figure 7-1 – Secondary Clarifier



7.2.1 Capacity

Activated sludge clarifiers are limited by two factors, overflow rate (OR) and solids loading rate (SLR), for proper performance. Hydraulic retention time (HRT) also is of interest. Operating parameters under current conditions for the activated sludge system are shown on **Table 7-1**. In addition to operating parameters at existing flow and MLSS conditions, SLR (if MLSS is increased to 3,000 mg/l) also is shown.

Table 7-1 - Secondary Clarifier Operating Characteristics

Parameter	Current	Recommended	Units
Diameter	55	---	feet (ft)
Surface Area	2,375	---	square feet (sf)
Overflow Rate			
Average Annual Flow [a]	587	400	gpd/SF
Peak Flow [b]	905	1,000	gpd/SF
Hydraulic Residence Time			
Average Annual [a, c]	2.4	2.0	hr
Peak Flow [b, c]	1.5	1.5	hr
Solids Loading Rate (MLSS=1,000 mg/L)			
Average Annual [a, c]	7	20	lb/day/SF
Peak Flow [b, c]	11	40-60	lb/day/SF
Solids Loading Rate (MLSS=3,000 mg/L)			
Average Annual [a, c]	22	20	lb/day/SF
Peak Flow [b, c]	34	40-60	lb/day/SF

[a] *Total flow of 2.79 mgd with two clarifiers in operation*

[b] *Total flow of 4.3 mgd with two clarifiers in operation*

[c] *Assuming RAS return rate of 50 percent*

Under current conditions, the clarifiers are operating at slightly higher overflow rates than normal design, but at lower solids loading rates. Because the SLR is well within design rates, this may be a significant factor in the success of the clarifiers in maintaining acceptable TSS in the secondary effluent. The clarifiers are hydraulically limited to current flows.

7.3 Return Activated Sludge Pumping

Three RAS pumps were installed when the aeration basins were constructed. One pump serves each clarifier, and the third is on standby. The rated pump capacities are 750 gpm at 21.5 feet TDH, for a total of approximately 2.15 mgd with two pumps in operation. The flow rate may be manually adjusted via variable frequency drives (VFDs). The RAS pumps measure flow and output on a circular chart recorder. **Figure 7-2** is a photo of the RAS pump room.

Figure 7-2 – RAS Pump Room

These pumps provide a sludge recirculation rate of 50 percent, for a maximum flow of 4.3 mgd as currently limited to the activated sludge system. Ten States Standards (Great Lakes, 2004) recommends that RAS pumping systems be designed for 20 to 100 percent. Consequently, the RAS pumps appear to be adequate for current operating conditions, including the maximum flow to the activated sludge system as currently limited to 4.3 mgd.

Chapter 8

Disinfection and Outfall System

Chapter 8 – Disinfection and Outfall System

8.1 General

Chlorine is added to the wastewater flow to destroy pathogenic and non-pathogenic organisms to prevent nuisances and to protect the recreational uses of the receiving water. The treatment plant processes reduce a large percentage of bacteria, and the disinfection by chlorination provides the final safeguard prior to discharge. Following chlorination and contact, removal of residual chlorine from the effluent occurs with mixing aqueous sulfur dioxide with the effluent. The dechlorination system was added during the 2008-2010 upgrades and related components are shown on the M04-sheets included in the record drawings. Also, refer to Contractor's Operation Maintenance Manuals for operation and maintenance recommendations specific to the installed dechlorination equipment.

> ***WARNING! Do not allow chlorine and sulfur dioxide gases to mix, this can lead to fires, explosions, and/or violent and dangerous exothermic chemical reaction.***

8.2 Chlorination

8.2.1 General

The chlorine disinfection system was originally constructed in approximately 1982 and was not modified during the 2008-2010 improvements. Attention is directed to the 1982 drawings and O&M information for further information. A photograph of the basins is included as **Figure 8-1**.

Ten States Standards recommends 15 minutes of retention time in chlorine contact tanks after initial mixing of wastewater flow with chlorine dose. Based on this criterion, the design flow limit is 7.9 mgd. Recent peak observed flows of >12 mgd result in a detention time of less than 10 minutes. Operators should confirm adequate disinfection exists during peak flows and increase dosing rates as necessary.

Figure 8-1 – Chlorine Contact Chamber and Flood Stage Pumps

Chorine dose is typically 12 pounds per day (ppd); however, during peak I/I events, usage may increase to 30 to 40 ppd. Chlorinated water can be discharged to the secondary clarifier effluent prior to entering the Chlorine Contact Chamber, RAS for filamentous control, and the headworks upstream of the rock box.

The effectiveness of the disinfection process is dependent upon the amount of chlorine added, the rate of dispersion of chlorine throughout the effluent, the size and amount of suspended solids present in the effluent, and the length of time that the effluent is exposed to the chlorine. Chlorine reacts with substances such as ammonia, hydrogen sulfide, and organic compounds containing nitrogen. These reactions reduce the concentration of the chlorine, which can impact disinfection effectiveness. Tests to check the effectiveness of the disinfection process are the residual chlorine test and fecal coliform count. The operator must take samples for these tests as grab samples. Residual chlorine is the total amount of chlorine remaining after a given period. If a measurable residual is present in the effluent from the contact basins after detention and the fecal coliform count is low enough, adequate disinfection has normally been achieved. If a chlorine residual cannot be measured, the chlorine feed rate at the chlorinator should be increased. It should be noted that the chlorine feed rate should not indiscriminately be increased.

If partial nitrification occurs within the aerobic process (reference Chapter 6), the plant could experience nitrite blocking. As a result, the effluent will have higher than normal TRC levels but disinfection will not be complete. The de-chlorination system will allow the operators to dose higher levels of chlorine and then remove it through the de-chlorination system.

The operator should continually monitor the performance of the system by testing the residual chlorine prior to dechlorination and E. coli levels in the effluent with samples taken per the NPDES Permit requirements. Residual chlorine is the total amount of chlorine remaining after a given period. If a measurable residual is present in the effluent from the contact basins after detention and the E. coli levels are low, adequate disinfection has normally been achieved. If a chlorine residual cannot be measured, the chlorine feed rate at the chlorinator should be increased. It should be noted that the chlorine feed rate should not be indiscriminately increased. Since dechlorination is required prior to discharge, unusually high levels of residual chlorine will only serve to expend additional chemicals unnecessarily.

8.2.2 Chlorine Gas Safety

General: As soon as there is any indication of the presence of chlorine in the air, immediate steps should be taken to correct the condition. Chlorine leaks never get better; they always get worse due to corrosion if they are not promptly corrected. When a chlorine leak occurs, authorized, trained personnel equipped with suitable air packs should investigate and take action. The City of Sandpoint's policy is to call the City Fire Department who will contact the appropriate hazardous materials response team. Whenever possible, no person should work alone on a chlorine leak. All other persons should be kept away from the affected area until the cause of the leak has been discovered and the trouble corrected. If the leak is extensive, all persons in the path of the fumes must be warned to leave the area. Keep upwind of the leak and above it. Because chlorine gas is approximately two and one-half times as heavy as air, it usually lies close to the ground; however, this may not be true inside buildings or where local air currents are present.

Emergency Assistance: If a chlorine emergency cannot be handled promptly by personnel at the site, call the nearest office or plant of the supplier for assistance. If the supplier cannot be reached, call the nearest chlorine producing plant where help is available. Chlorine producing plants operate around the clock and can be reached by telephone at any time. The telephone numbers of the supplier of the nearest chlorine producer who is able to provide assistance in an emergency should be posted in a suitable place so that they will be quickly available if needed; these should be checked periodically to insure accuracy.

When phoning for assistance, give the following:

- Name of chlorine supplier
- Your facility name, address, telephone number, and the person or persons to contact for further information
- Travel directions to emergency site
- Type and size of container
- Nature, location and extent of emergency
- Corrective measures being applied

Fires: In case of fire, chlorine containers should be removed from fire zone immediately. If no chlorine is escaping, water should be applied to cool containers that cannot be moved. All unauthorized personnel should be kept at a safe distance.

Leaks: To find a leak, tie a cloth to the end of a stick, soak the cloth with aqua ammonia and hold close to the suspected area. A white cloud will result if there is any chlorine leakage. Avoid contact of ammonia with brass. Commercial strength (26° Baume) aqua ammonia should be used (household ammonia is not strong enough).

Never use water on a chlorine leak. Chlorine is only slightly soluble in water; also, the corrosive action of chlorine and water will always make a leak worse.

If a leak occurs in equipment or piping, shut off the chlorine supply, relieve the pressure and make necessary repairs. If welding is needed, purge the system with dry air (nitrogen or carbon dioxide also may be used) before proceeding. Welding should comply with all applicable codes.

Leaks around valve stems usually can be stopped by tightening the packing gland or packing gland nut by turning clockwise. If this does not stop the leak, the container valve should be closed; if it does not shut off tight, the outlet cap or plug should be applied.

Container Leaks: These additional actions may be taken to contain and control leaks:

1. If a container is leaking chlorine, turn it if possible so that gas instead of liquid escapes. The quantity of chlorine that escapes from a gas leak is about one-fifteenth the amount that escapes from a liquid leak through the same size hole.
2. It may be desirable to move the container to an isolated spot where it will do the least harm.

3. If practical, reduce pressure in the container by removing the chlorine as gas (not as liquid) to the chlorine mixing basin.
4. Apply emergency repair kit device.
5. Never immerse or throw a leaking chlorine container into a body of water; the leak will be aggravated and the container may float when still partially full of liquid chlorine, allowing gas evolution at the surface.
6. Call for emergency assistance.

It is illegal to ship a leaking chlorine container or a container that has been exposed to fire, whether full or partially full. However, it may be desirable under some circumstances to ship a defective chlorine container to which an emergency device has been applied. Consult your chlorine supplier.

Emergency Kit: Emergency kits have been designed to contain most leaks that may be encountered in chlorine shipping containers. These kits operate on the principle of capping off leaking valves or, in the case of cylinders and ton containers, of sealing off a leak in the side wall. Capping devices are provided for fusible plugs in ton containers.

For additional information, consult the existing chlorine safety O&M material from the 1974 and 1982/83 upgrades.

8.3 Sulfur Dioxide Dechlorination

8.3.1 General

The 2008-2010 Improvements added dechlorination capabilities to remove residual chlorine from the treated effluent. The 2008-2010 improvements expanded the existing Chlorine Building to the west with the addition of two separate rooms for Dechlorination (Dechlorination Support Room and Dechlorination Gas Storage Room).

The Sandpoint WWTP uses gaseous sulfur dioxide as their dechlorination agent. Sulfur dioxide (SO_2) is a corrosive, nonflammable gas with a characteristic pungent odor. At atmospheric temperature and pressure, it is a colorless vapor. When compressed and cooled, it forms a colorless liquid. Sulfur dioxide is supplied as liquefied gas under pressure in 100 or 150 pound containers and one-ton cylinders. The City of Sandpoint uses 150 lb cylinders.

The dechlorination chemical feed equipment is located in the Dechlorination Gas Storage Room in the Disinfection Building. Current regulations require storage of sulfur dioxide in a separate "control area." The Dechlorination Gas Storage Room meets regulation requirements for storing a maximum of 900 lbs of sulfur dioxide, including active cylinders. Note the Dechlorination Support Room is not intended to store other chemicals or gas containers.

The dechlorination equipment consists of:

- 150 lb sulfur dioxide gas cylinders, vacuum regulators, and cylinder scales
- US Filter/Wallace and Tiernan V10K Gas feed systems and injector

- Chlorine Residual Analyzer for dose control
- Carrier water pump, piping, and valves
- Injection solenoid valves, spray bar, and injection quill at the Chlorine Contact Chamber

Contact information for the dechlorination equipment is:

US Filter / Wallace and Tiernan (Manufacturer)
1901 West Garden Road
Vineland, NJ 08360
Phone: 1-856-507-9000
Fax: 1-856-507-4125

Spokane Instrument (representative)
Bob Lithgow
862 Davis Road
Usk, WA 99180
Phone: 509-445-0687
Cell: 509-991-8060
Fax: 509-445-0688
Email: spokins@povn.com

A schematic of the dechlorination chemical feed system appears on the MO4 sheets of the Record Drawings. Photographs of the dechlorination system are included for visual reference on **Figure 8-2** through **Figure 8-7**.

8.3.2 System Operation

The WWTP utilizes two banks of two 150 lb Sulfur Dioxide gas cylinders (four total) with the potential to expand each bank with an additional cylinder. The banks are connected to one remote vacuum switchover unit. The intended operation is for one bank to be online with the others full and on standby, ready for use. When the online bank becomes empty, the remote vacuum switchover unit will automatically switchover and draw from the full bank. The operators should replace the empty bank with full 150 lb cylinders.

The manifold gas supply lines route to the Wallace and Tiernan V10K gas feed system, which controls the dose. The dose is determined by the chlorine residual in the outlet channel (upstream of the Parshall flume) and the current flow (see below for further discussion) or is set manually. Currently, the chlorine residual from the Chlorine Contact Chamber is too low to allow proper operation of the automatic controller. Manual operation is therefore the preferred operational scheme.

Non-potable water supply fed by the plant water reuse system (discussed in subsequent sections) enters the Dechlorination Support Room and then the Dechlorination Gas Room. The flowing water creates a vacuum in the injector, drawing a measured amount of gas through the gas feed system into the injector. The sulfur dioxide is injected into the non-potable supply to form sulfur dioxide solution that is fed to the Chlorine Contact Chamber outfall channel for injection into the wastewater effluent.

Figure 8-2 – Dechlorination Gas Controller

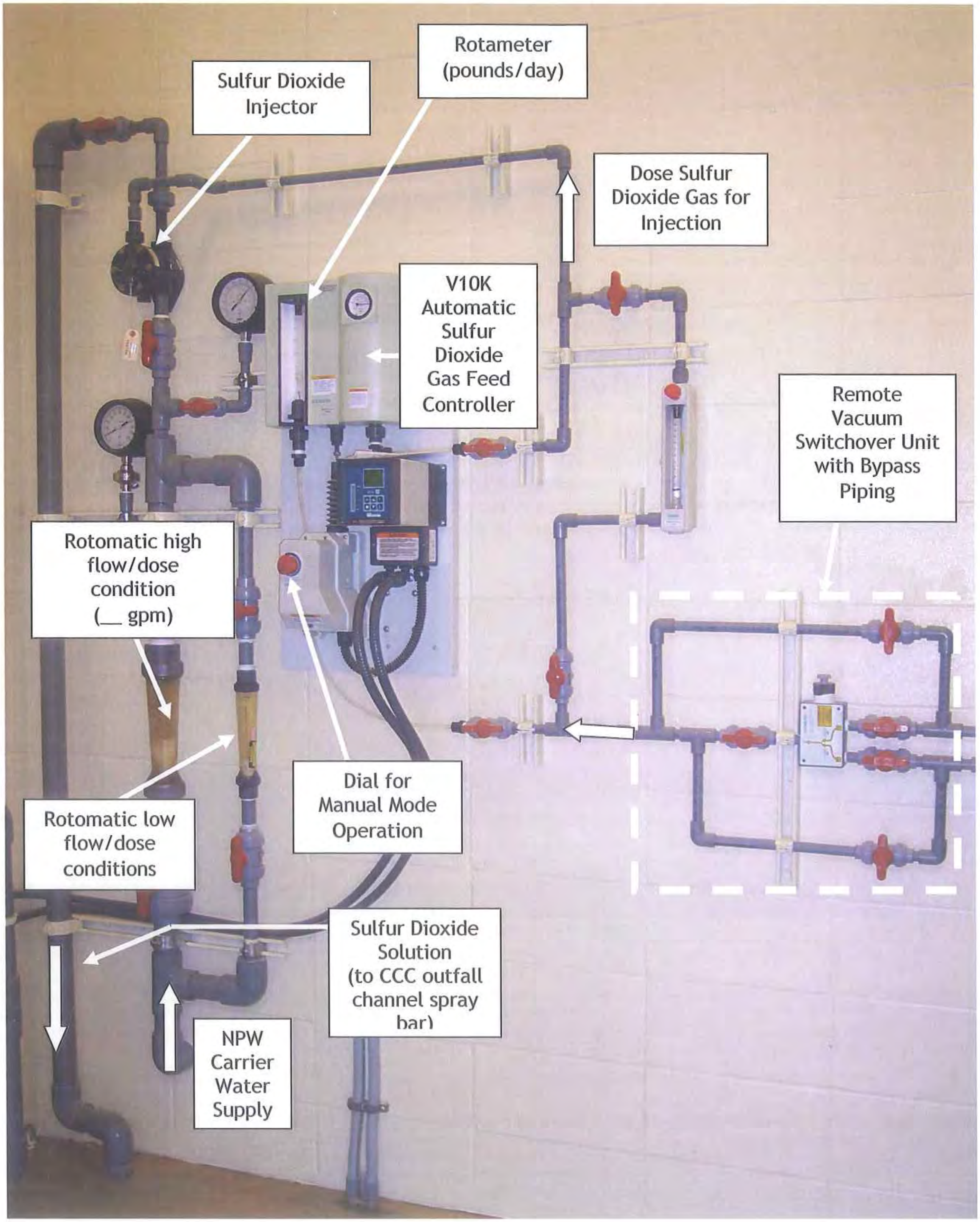


Figure 8-3 – Dechlorination Gas Cylinders and Manifold

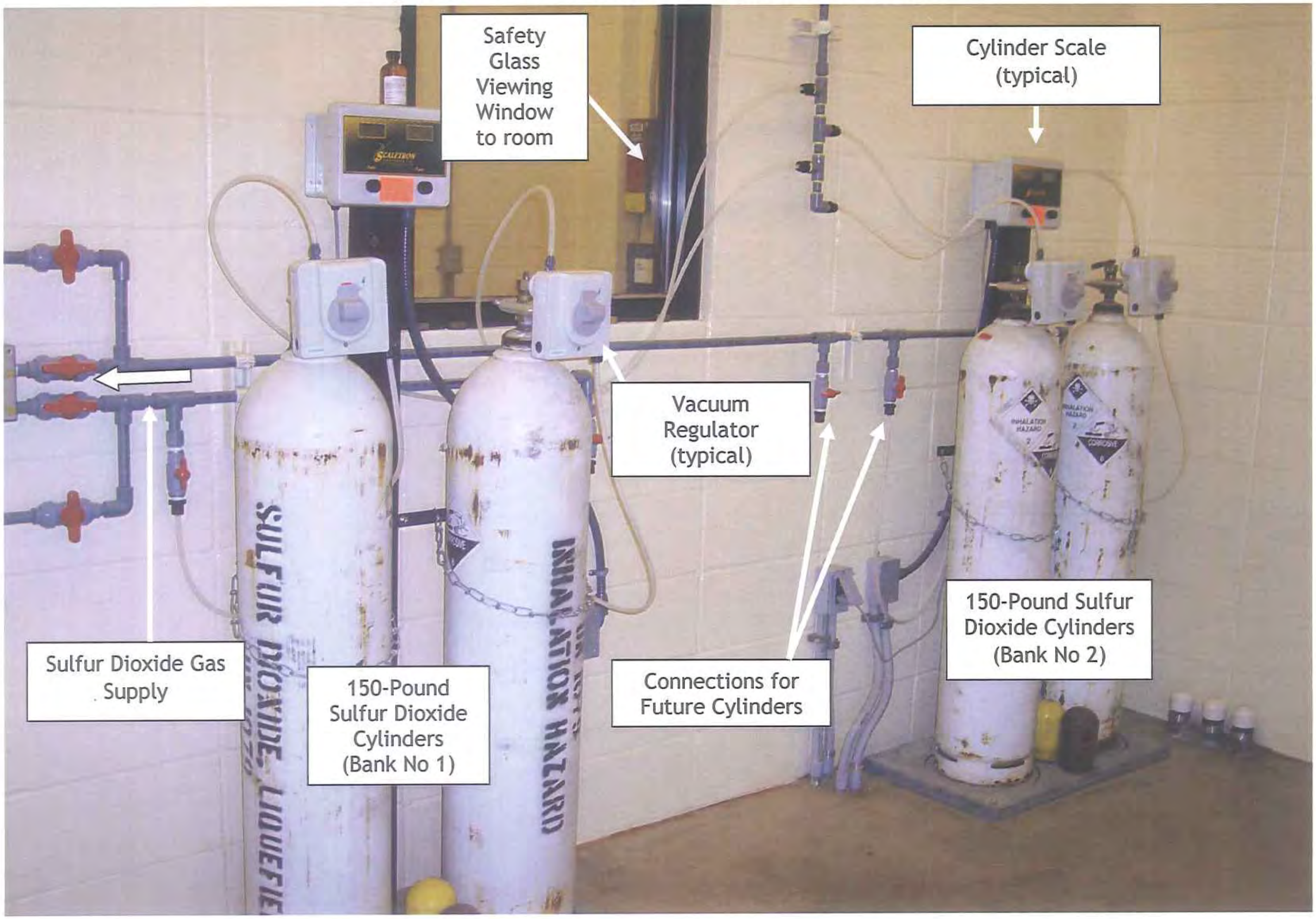


Figure 8-4 – Dechlorination Gas Sampler

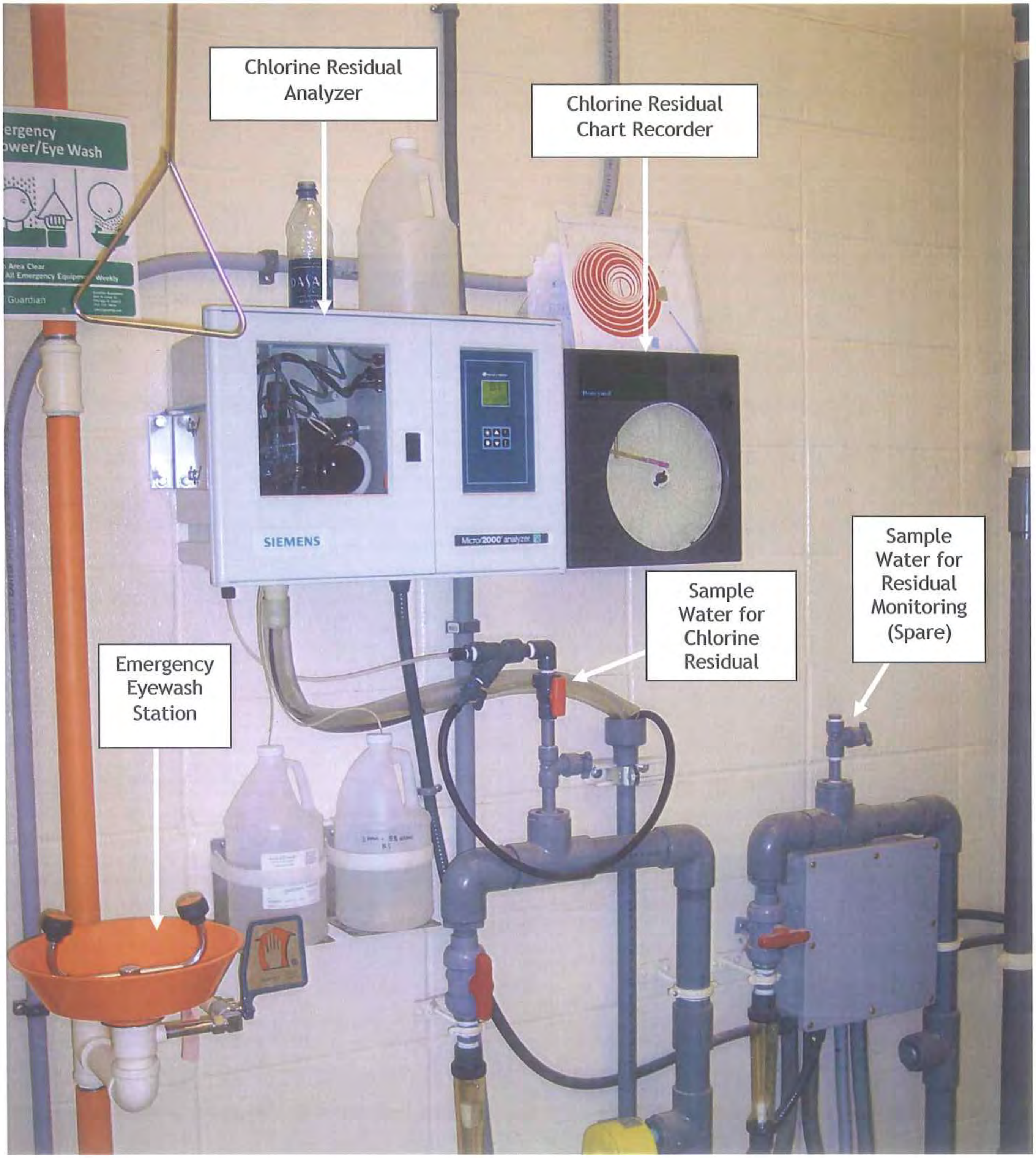


Figure 8-5 – Sample Pump and Sample Water Discharge

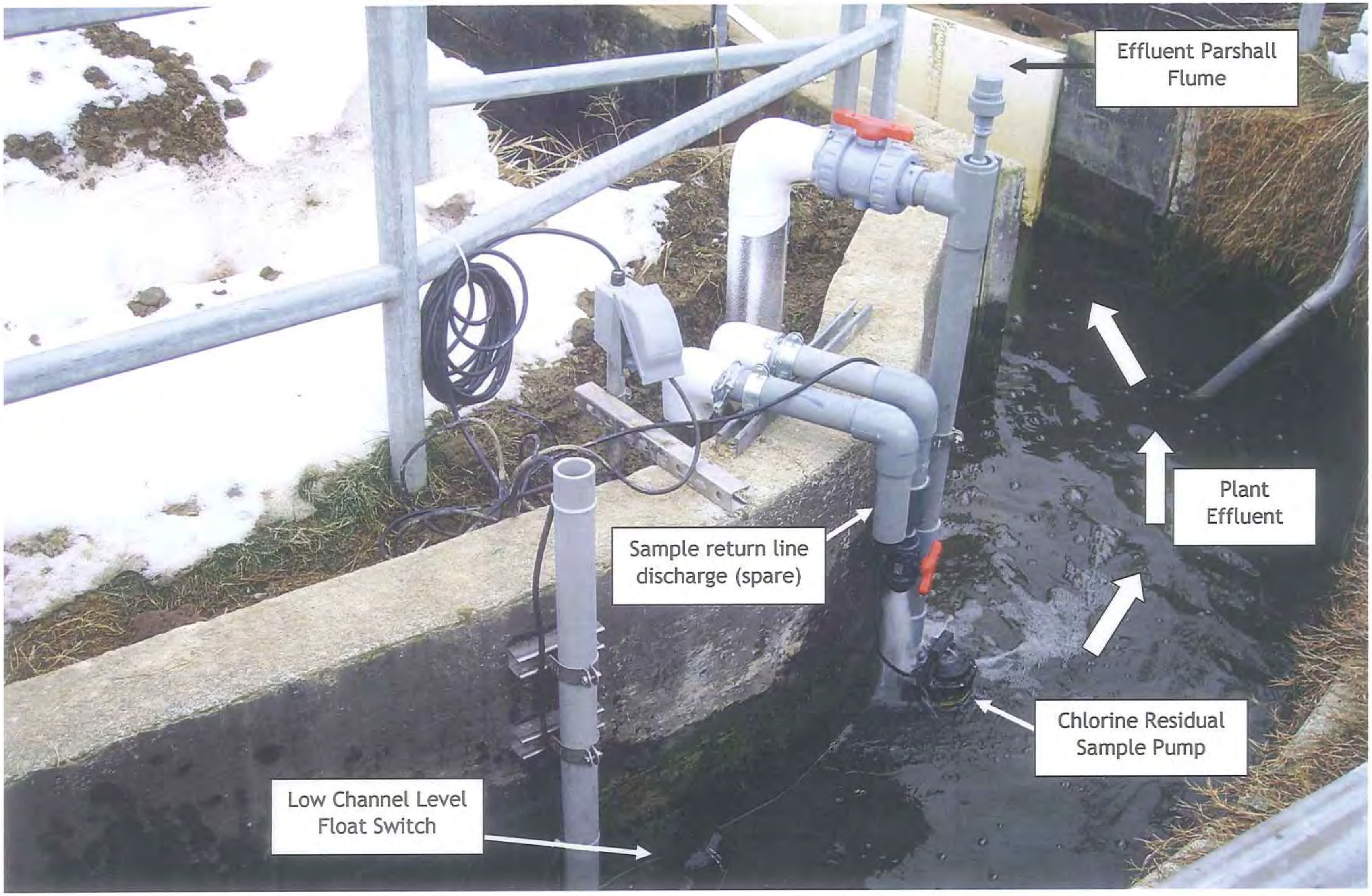


Figure 8-6 – Dechlorination Injection Location (Normal Operation)

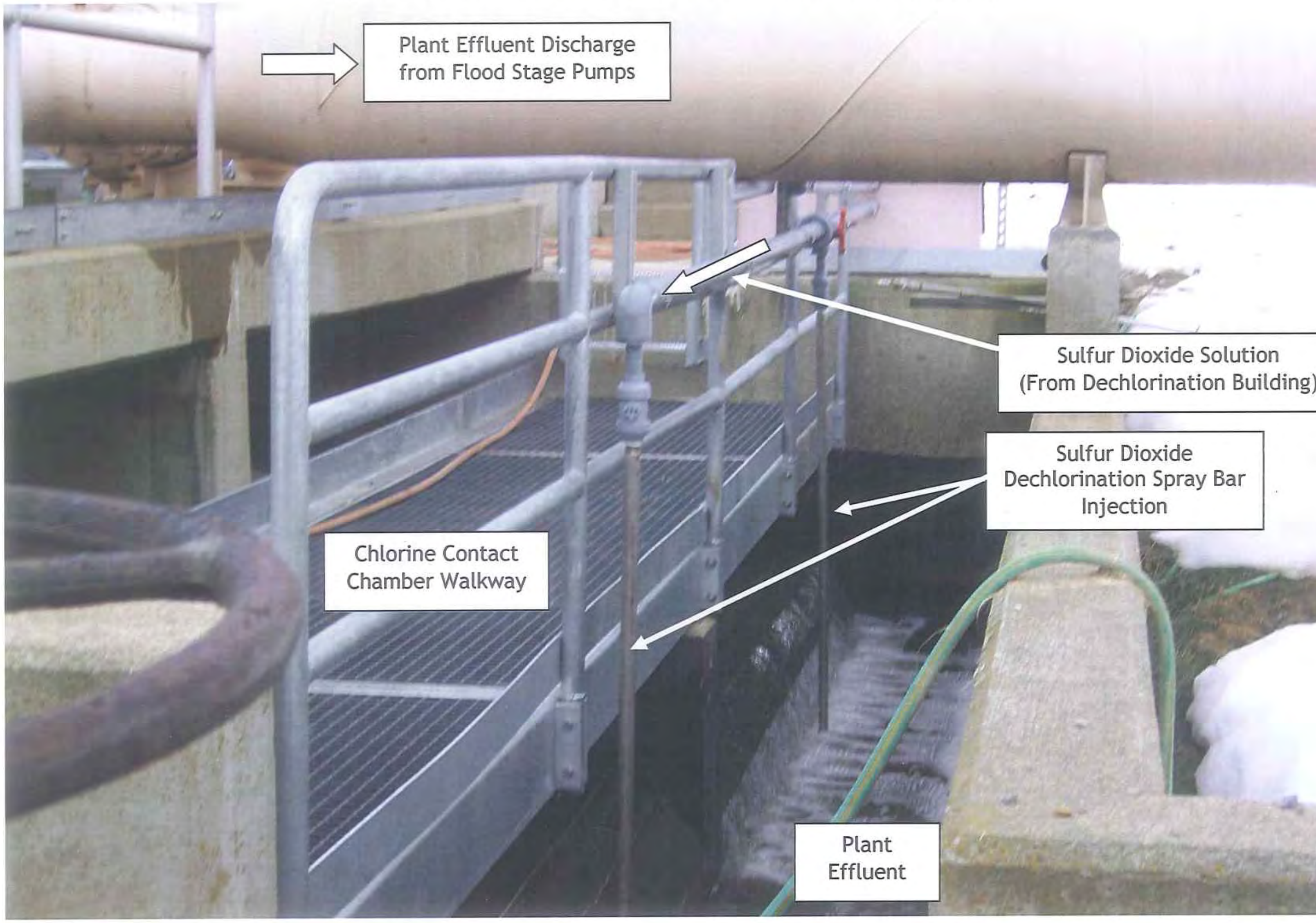
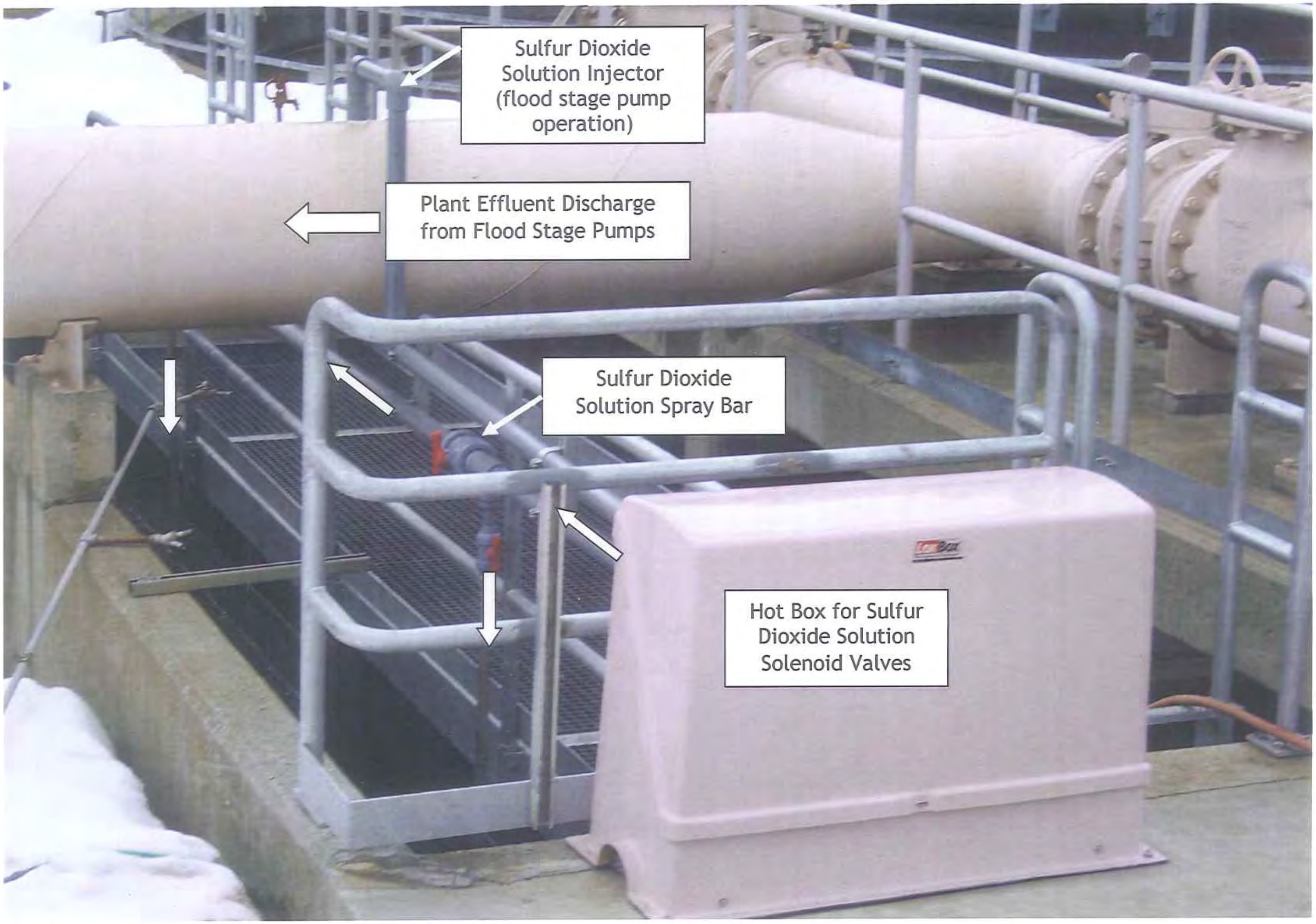


Figure 8-7 – Dechlorination Injection (Normal Operation and into Flood Stage Pump Discharge Line)



The sulfur dioxide feed to the process may be calculated as follows:

$$Pounds\ SO_2\ Required = Q\ (mgd)\ x\ TRC\ (mg/l)\ x\ 8.34\ x\ FOS$$

Where:	Q	=	Discharge Flow, in million gallons per day (cfs); note 1 cfs 448.8 gpm = 0.646 mgd
	TRC	=	Total Residual Chlorine, milligrams per liter (mg/l)
	8.34	=	Conversion factor to obtain lb/day
	FOS	=	Factor of Safety to obtain full oxidation of the residual chlorine; typically 1.25 to 1.5

At 3.0 mgd flow, a 1.0 mg/l residual chlorine level, and a factor of safety of 1.25, the sulfur dioxide use would be as follows:

$$(3.0)(1.0)(8.34)(1.25) = 31.25\ lbs/day$$

The theoretical maximum gas that can be pulled from one cylinder is 40 lbs/day. At a flow of 11.0 mgd, this results in a maximum SO_2 dose of 1.74 mg/L.

8.3.3 Normal Operating Conditions

Normal operating conditions occur when the flood stage pumps are off and WWTP effluent flows are less than approximately 11 mgd. Under these flow conditions, the wastewater travels through the Chlorine Contact Chamber and out the effluent Parshall flume. This condition allows for a feedback control scheme. Sulfur dioxide dose is controlled manually or by sensing the chlorine residual following dechlorination. Because the dosing point is downstream of the injection point, or in "back," this approach is referred to as a "feed-back" control scheme. A "feedback" control scheme is used since the City is not required to dechlorinate their effluent to "zero/non-detect" levels for chlorine.

With feedback control, the effluent sample pump feeds sample water from the downstream side of the sulfur dioxide injection to the V10K controller in the Dechlorination Gas Storage Room. A sample is pulled off the sample line from the chlorine residual analyzer in the Dechlorination Gas Storage Room, and the residual should be approximately 0.1 mg/L if dosing correctly (the current permit limit is 0.45 mg/L for a daily average). The chlorine residual analyzer sends a signal to the controller and to the chart recorder. The controller also receives a signal from the influent flow meter, allowing for compound loop/flow proportioned control over dosing (i.e., chlorine residual multiplied by the flow to determine the total demand).

The sulfur dioxide solution is routed to the effluent flow stream at the Chlorine Contact Chamber outfall channel via a spray bar injection system using a carrier water stream. The solution mixes into the wastewater by turbulence on the discharge side of the Chlorine Contact Chamber effluent weir.

The operator should note the system does not have the capability to measure sulfur dioxide residuals, and dosing is based on chlorine residual monitoring. Therefore, care should be taken to minimize sulfur dioxide overdosing. The operator should continually monitor the sulfur dioxide dose until a slight chlorine residual is observed, then slightly increase the dose to minimize overdose.

Spare conduits for effluent sample water are also available to modify the control scheme in the event plant operations require sulfur dioxide residuals. This may be critical if an effluent dissolved oxygen in the NPDES Permit, as sulfur dioxide, removes dissolved oxygen from water.

8.3.4 Alternate Operating Conditions

8.3.4.1 Flood Stage Pumps in Operation

The flood stage pumps were constructed in 1983 to allow discharge of treated effluent during high flows in the Pend Oreille River. The pumps are located at the end of the Chlorine Contact Chamber and pump directly to the outfall structure, bypassing the effluent Parshall flume. The pumps are rated at 5,175 gpm at 13.5 feet TDH each to meet the peak flow condition of 14.7 mgd (as noted in the 1982 Wastewater Facilities Plan).

No operational problems have been noted; however, use of the flood stage pumps results in no flow measurement during operation and potentially reduced contact time during the chlorination process. Both shortcomings potentially compromise the effluent quality to the receiving waters.

Alternate flow operating conditions occur when the flood stage pumps operate. This has historically occurred at the plant a few times each year. Under these flow conditions, the water level in the Chlorine Contact Chamber will rise until floats in the CCC trigger the flood stage pumps to start, thereby removing wastewater from the Chlorine Contact Chamber. The pumps will turn off when the level in the CCC lowers to the float low-level controlling the "pump off." Flow from the flood stage pumps bypasses the effluent Parshall flume meter since flow is discharged downstream of the flume.

Since the effluent flow meter is bypassed, the chlorine residual sample pump will no longer deliver a stream of sample water to the chlorine residual analyzer. Under this condition, the controller will default to an automatic dose based on an adjustable concentration and the flood stage pump capacity. This method of dose control will occur until the influent flow reduces and the flood stage pumps are no longer necessary. Under these conditions, the sulfur dioxide solution is injected into the discharge side of the flood stage pumps with an injection quill (see **Figure 8-7**).

8.3.5 Sulfur Dioxide Equipment Cleaning, Repairs, and Maintenance

Cleaning and repair of sulfur dioxide equipment should be under the direction of thoroughly trained personnel who are familiar with all of the hazards and safeguards necessary for the safe performance of the work. All precautions pertaining to education, protective equipment and health, and fire hazards should be reviewed and understood.

No one should attempt to repair sulfur dioxide gas piping or other equipment while it is in service. When the system is to be cleaned or repaired, tanks, piping, and other equipment should always be thoroughly purged with an inert gas.

Components of the manifold—especially flexible connectors, valves, and the injector and solution system—are the most likely to need repair. In view of this, these components should be inspected at least every six months. Additionally, diaphragms and injector gaskets should be replaced every two years. The gasket should be replaced each time the joint is broken in a gasketed pressure connection. Asbestos fiber gaskets are not recommended because they often do not seal properly. Used gaskets should *never* be re-used. Springs should be replaced according to the manufacturer's instructions. Spare parts—especially parts for the pressure manifold—and standby equipment, should be kept on hand to prevent significant down time in the event of equipment problems.

<u>Sulfonators should never be used or treated like standby chlorinators even though sulfonators are configured with similar components as chlorinators.</u> Chlorinators and sulfonators are composed of different polymeric materials (sulfonators typically of PVC and chlorinators of ABS plastic), each chosen for application-specific chemical resistance. Use of non-chemical resistant materials with chlorine or sulfur dioxide gases can lead to equipment failure. Moreover, equipment misuse leading to accidental mixing of chlorine and sulfur dioxide gases can lead to an exothermic chemical reaction and equipment failure.

Water can be used to clean most component surfaces. For buildup of impurities or for stains, a dilute hydrochloric (muriatic) acid solution may be necessary (WEF, 1996). Following cleaning, the components must be thoroughly dried before they are reassembled. Drying is best done using compressed dry air or nitrogen.

The chlorine residual analyzer analyte should be checked daily and refilled as necessary. Contact the local equipment representative for the appropriate analyte.

8.4 Sulfur Dioxide Safety

A complete discussion of the safety and handling requirements for sulfur dioxide gas are included in the Material Safety Data Sheet (MSDS) for sulfur dioxide, located in **Appendix E.** Proper handling is critical to avoid injury to operators. A brief summary of the safety concerns and critical safety measures is included below:

8.4.1 Common Effects to Living Animals and Humans

Eye and Skin Effects:

- Corrosive and irritating to the eyes. Contact with the liquid or vapor causes painful burns and ulcerations.
- Burns to the eyes result in lesions and possible loss of vision.
- Corrosive and irritating to the skin and all living tissue. Toxic level exposure to dermal tissue causes acid-like burns and skin lesions resulting in early necrosis and scarring.

Inhalation Effects:

- Corrosive and irritating to the upper and lower respiratory tract and all mucosal tissue. Initial symptoms of Exposure includes nose and throat irritation, becoming steadily worse, suffocating and painful.

- The irritation extends to the chest causing a cough reflex which may be violent and painful and may include the discharge of blood or vomiting with eventual collapse. Other symptoms include headache, general discomfort and anxiety.
- Chemical pneumonitis and pulmonary edema may result from exposure to the lower respiratory tract and deep lung.
- Repeated or prolonged low level exposures may cause corrosion of the teeth.
- Reproductive toxicity and developmental changes in newborn have been observed in experimental animals exposed to sulfur dioxide.

8.4.2 First Aid Measures

Eyes:

- PERSONS WITH POTENTIAL EXPOSURE SHOULD NOT WEAR CONTACT LENSES.
- Flush contaminated eyes with copious quantities of water. Part eyelids to assure complete flushing. Continue for a minimum of 15 minutes. Seek immediate medical attention.

Skin:

- Remove contaminated clothing as rapidly as possible. Flush affected area with copious quantities of water.
- Seek immediate medical attention.

Ingestion/Inhalation:

- PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVER EXPOSURE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS.
- Victims should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. If breathing has stopped administer artificial resuscitation and supplemental oxygen.
- Further treatment should be symptomatic and supportive.

8.4.3 Accidental Release Measures

Evacuate all personnel from affected area. Use appropriate protective equipment. If leak is in user's equipment, be certain to purge piping with inert gas prior to attempting repairs. If leak is in container or container valve, contact the appropriate emergency telephone numbers, located in Chapter 20 of this manual.

8.4.4 Handling and Storage

The following handling procedures are recommended:

- Most metals corrode when in contact with wet sulfur dioxide; therefore, the area should remain well ventilated.

- Valve protection caps must remain in place unless container is secured with valve outlet piped to use point.
- Do not drag, slide, or roll cylinders. Use a suitable hand truck for cylinder movement.
- Use a pressure reducing regulator when connecting cylinder to lower pressure (<150 psig) piping or systems.
- Do not heat cylinder by any means to increase rate of product from the cylinder.
- Use a check valve or trap in the discharge line to prevent Hazardous back flow into cylinder.
- Protect cylinders from physical damage.
- Store in cool, dry, well-ventilated areas of non-combustible construction away from heavily trafficked areas and emergency exits.
- Do not allow the temperature where cylinders are stored to exceed 130° F (54° C).
- Cylinders should be stored upright and firmly secured to prevent falling or being knocked over.
- Full and empty cylinders should be segregated. Use a "first in-first out" inventory system to prevent full cylinders from being stored for excessive periods of time.

WARNING! Do not allow chlorine gas and sulfur dioxide gases to mix, this can lead to fires, explosions, and/or violent and dangerous exothermic chemical reaction.

8.4.5 Safety Equipment

- **Eye/Face Protection:** Full-face piece respirator or gas-tight goggles recommended.
- **Skin Protection:** Plastic or rubber.
- **Respiratory Protection:** Positive pressure air line with full-face mask and escape bottle or self-contained breathing apparatus should be available for emergency use.
- **Other/General Protection:** Safety shoes, safety shower, eyewash "fountain", face shield.

8.4.6 Leaks

To find a leak, tie a cloth to the end of a stick, soak the cloth with aqua ammonia, and hold close to the suspected area. A white cloud will result if there is any leakage. Avoid contact of ammonia with brass. Commercial strength (26° Baume) aqua ammonia should be used (household ammonia is not strong enough).

Never use water on a sulfur dioxide gas leak. Sulfur Dioxide is only slightly soluble in water; also, the corrosive action of sulfur dioxide gas and water will always make a leak due to the creation of sulfuric acid. If a leak occurs in equipment or piping, shut off the chlorine supply, relieve the pressure, and make necessary repairs. If welding is needed, purge the system with dry air (nitrogen or carbon dioxide also may be used) before proceeding. Welding should comply with all applicable codes.

Leaks around valve stems usually can be stopped by tightening the packing gland or packing gland nut by turning clockwise. If this does not stop the leak, the container valve should be closed; if it does not shut off tight, the outlet cap or plug should be applied.

8.5 Maintenance and Monitoring Activities

8.5.1 Alarms

Check the electrolyte supply daily and replenish as necessary. Check the audible alarm weekly by activating the alarm. See the manufacturer's O&M information for testing the alarm system.

A dual light alarm system was installed in the 2008-2010 upgrade. The **red** beacon light indicates a **chlorine** gas leak. The **yellow** beacon light indicates a **sulfur dioxide** gas leak. The City's Fire Department should be contacted in the event of a gas leak. The City Fire Department will contact the appropriate hazardous materials response team.

8.5.2 Sulfur Dioxide Residual Analyzer

System performance should be monitored continually by testing the residual chlorine prior to the final outfall to verify compliance with the NPDES Permit. No residual dechlorination agent monitoring is required. However, the operators should use only as much as required to consume residual chlorine from the Chlorine Contact Chamber to minimize chemical costs. Additionally, excessive sulfur dioxide in the receiving stream may increase toxicity. Periodic monitoring and verification of the automatic dosing system will be required to verify the equipment is applying correct dosage throughout the year.

Drain and clean the contact channel as necessary, but no less than once a year.

8.6 Effluent Flow Measurement

WWTP effluent flow measurement is accomplished in a 12-inch Parshall flume downstream of the Chlorine Contact Chamber and SO_2 injection area immediately before the outfall structure. The rated free-flow capacity of a 12-inch Parshall flume is 10.4 mgd, which cannot accurately capture the peak day flows for this facility.

8.7 Outfall Structure

The WWTP outfall structure was built in the 1970s and extended in the 1983 upgrades, to a total length of approximately 925 feet. The outfall structure currently consists of a 3-foot-diameter steel-coated line, partially buried in the Pend Oreille River, with 3-inch-diameter ports spaced at 4 feet on center for the last 165 feet of the line. A diver was commissioned by the City to record the current condition of the outfall line. The inspection revealed a leak at the junction manhole, approximately 400 feet from the shore. The remainder of the outfall line appeared to be in satisfactory condition.

The outfall structure functions by evenly distributing flow to all diffusers in the river. The nominal diffuser port velocity is approximately 3.4 times greater than the nominal outfall pipe velocity. This increased port velocity results in a sizeable head loss at the diffuser rather than at the main pipe, which effectively maintains an equal discharge condition throughout the line. However, the high port velocities lead to high head loss. At a peak flow of 14.7 mgd (1982 wastewater facilities plan), head loss in the diffusers may reach 4.9 feet. This head loss, in addition to the losses in the outfall structure and outfall pipe during flood stages in the Pend Oreille River, could potentially overtop the outfall structure. The capacity of the existing outfall structure is conservatively estimated at 12.4 mgd during a 100-year flood event in the river (flood stage elevation 2071.0). During normal high water conditions, adequate freeboard exists in the outfall structure to pass a peak flow of approximately 20.0 mgd.

Chapter 9

Biosolids Handling: Primary Sludge and Thickened Sludge Pumping

Chapter 9 – Biosolids Handling: Primary Sludge and Thickened Sludge Pumping

9.1 General

Prior to the 2008-2010 upgrades, the existing primary and thickened sludge pumps were piston style positive displacement pumps. The recent upgrades replaced these aging pumps with rotary lobe pumps and improved the piping system, which allows the operators to move primary and thickened solids throughout the WWTP (i.e., to the rotary screen thickener, gravity thickener, or digester) while still maintaining a controlled flow rate at varying discharge pressures.

9.2 Primary and Gravity Thickened Sludge Pumping

Primary solids settle out of the liquid flow stream in the primary clarifiers. Solids are removed from the clarifiers by the primary sludge pumps located in the primary sludge pump station (reference the M09 drawings in the Record Drawing set).

There are two primary sludge pumps, each pump dedicated to one primary clarifier (Pumps No. 5 and No. 7). The primary sludge pump station conveys settled sludge from the two primary clarifiers to either the gravity sludge thickener, rotary screen thickener, the anaerobic digester, the solids holding tank, or to a liquid hauling port near the primary clarifier scum tank. Pumps No. 6 and No. 8 serve as a backup to primary sludge pumps. They are also utilized to drain the scum sumps for the primary clarifier and gravity thickener, and also drain the gravity thickener.

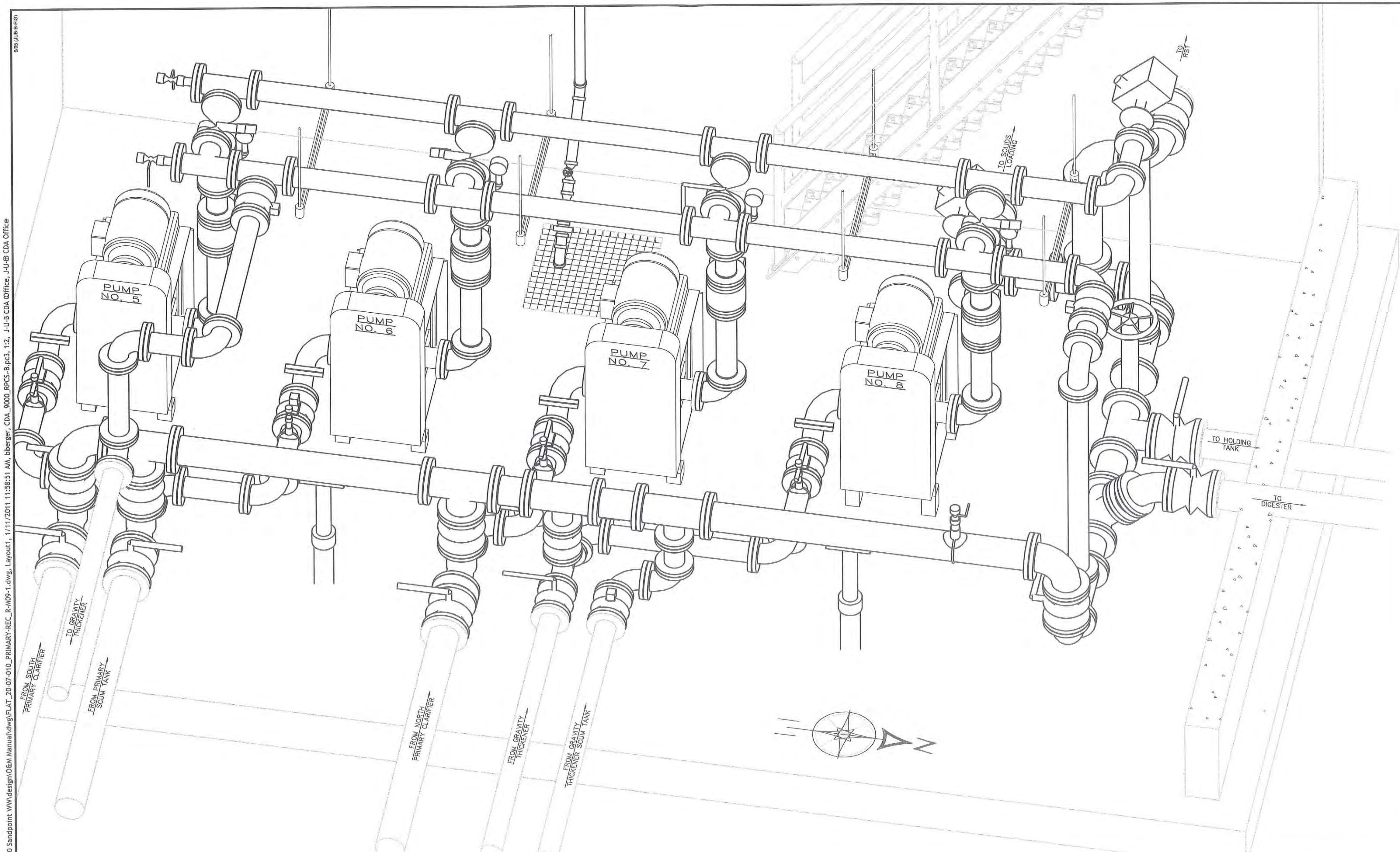
All four pumps are equally sized and have an integrated common suction header that allows the pumps to be used interchangeably. The discharge headers also allow a multitude of uses.

The rotary lobe positive displacement pumps were supplied by Correct Equipment Co. and manufactured by Vogelsang. The operator should refer to the manufacturer's O&M Manual for detailed operation and maintenance procedures. Contacts for the pumps are:

Vogelsang Pumps
Mark Thomas
7966 State Rt. 44
Ravenna, OH 44266
Phone: 330-296-3820

Correct Equipment, Inc. (Representative)
Steve Doyle
14576 NE 95th St.
Redmond, WA 98052
Phone: 425-869-1033
Cell: 425-466-2201
Fax: 425-869-1033

A photograph of the pumps is included as **Figure 9-1**. A 3-dimensional representation of the primary pump system is included as **Figure 9-2**, and a detailed process schematic for the system is included as **Figure 9-3**.



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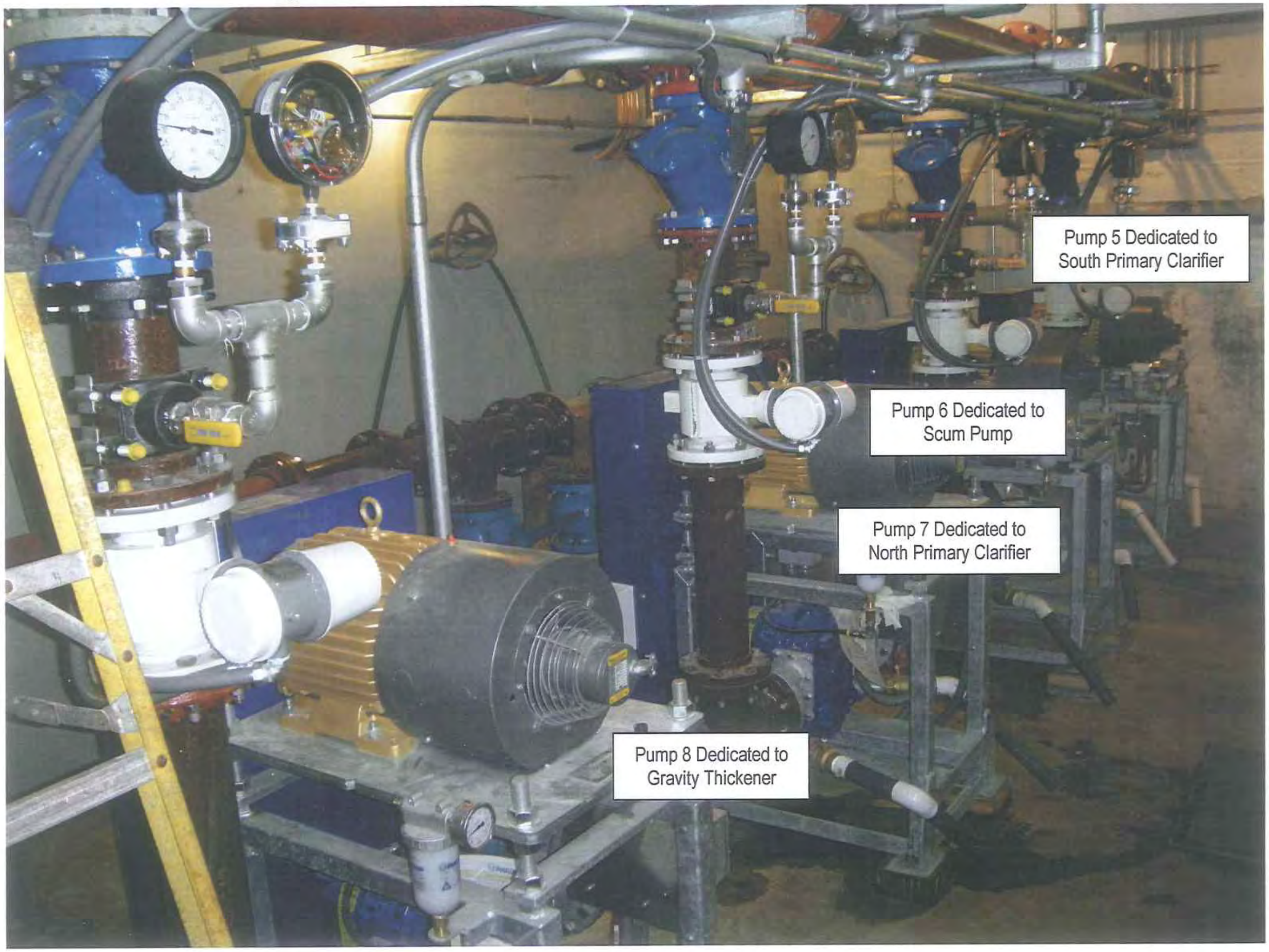
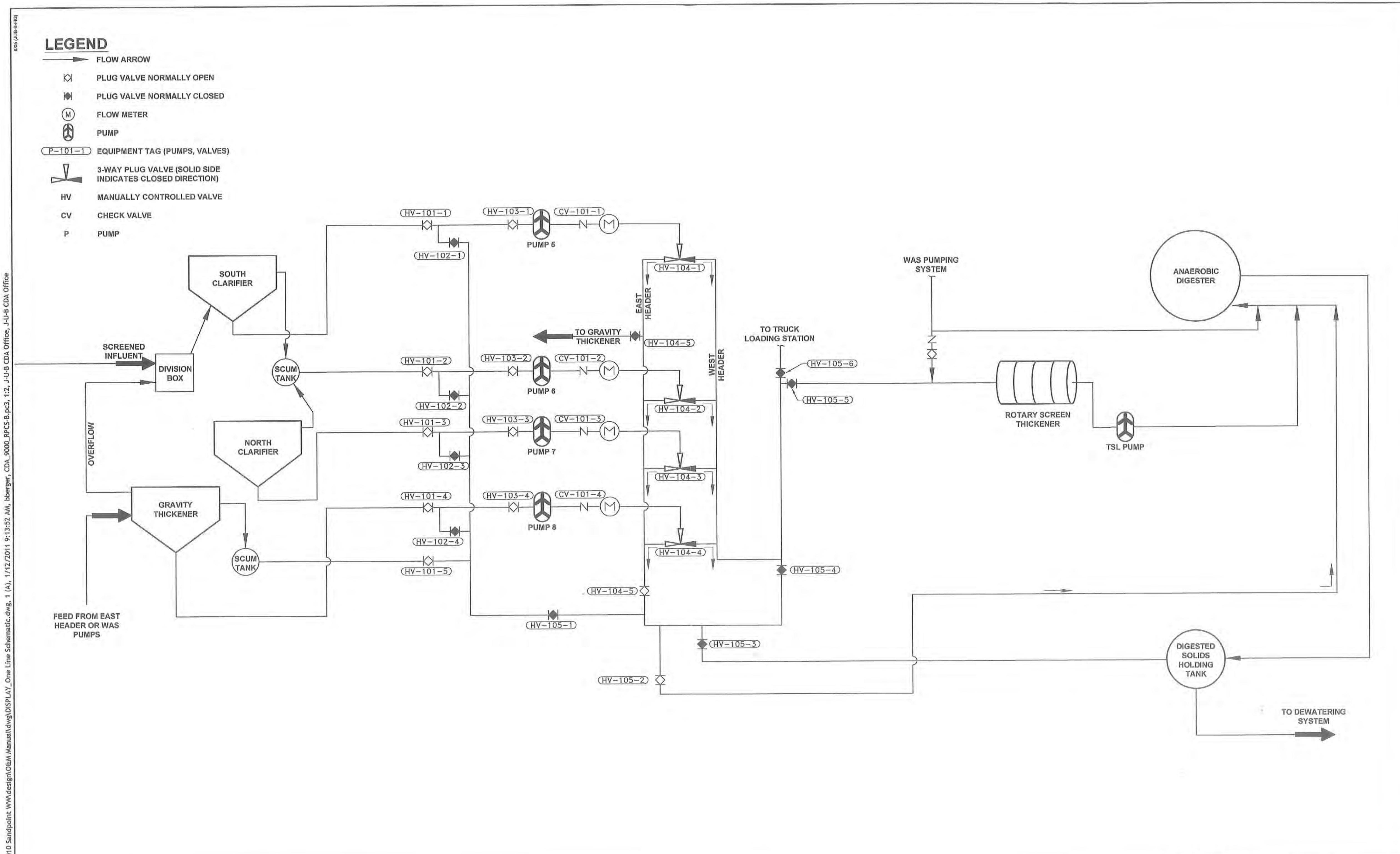
CAD FILE: FLAT_20-07-010_PRIMARY-REC_R-M09-1

CITY OF SANDPOINT
WASTEWATER TREATMENT PLANT O&M

PRIMARY AND THICKENED SOLIDS PUMP STATION - 3-DIMENSIONAL REPRESENTATION
FIGURE 9-1

Figure 9-2 – Primary and Thickened Solids Pump Station (Photograph)





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CAD FILE: DISPLAY_One Line Schematic

CITY OF SANDPOINT
WASTEWATER TREATMENT PLANT O&M

PRIMARY AND THICKENED SOLIDS PUMP STATION - PROCESS SCHEMATIC
FIGURE 9-3

9.3 Primary and Sludge Transfer Pumping System Operation

The primary and sludge transfer pumps are used for several functions at the WWTP under normal and emergency conditions. They are designed to pump up to 100 gpm at 50 psi discharge pressure. Under normal operation, the pumps will pump on a duty cycle (e.g., 3 minutes on and 15 minutes off) to more closely match solids accumulation in the clarifiers. Less frequent operation will result in thicker solids. This is advantageous because it reduces volumetric (liquid) loading to the anaerobic digester. However, thicker solids can result in higher discharge pressures and potentially clog suction or discharge lines. To achieve a longer hydraulic residence time in the anaerobic digester, it is recommended that the primary pumps are operated less frequently in order to achieve a primary solids concentration of at least 3 percent.

9.3.1 Normal Operation

Under normal operating conditions, Pumps No. 5 and No. 7 pull solids from a dedicated primary clarifier and discharge to the anaerobic digester directly.

These pumps operate based on a timer operation that allows the operator to determine how much of the time the pumps will discharge settled primary sludge to the downstream solids handling processes, and how much time the pumps are off. During each of these time periods, the speed of the pump VFD is adjustable to obtain the desired pumping rate.

If the gravity thickener is being used in the plant solids handling operation, then Pump No. 8 pulls settled solids from this tank and discharges to the downstream solids handling systems. Similar to Pumps No. 5 and No. 7, this pump is also operated on a timer setting with adjustable speed control when the pump is operating.

Under normal operation, Pump No. 6 serves as a redundant pump for each of the other three pumps in this station or is used to drain the scum tanks for the primary clarifiers and gravity thickener.

9.3.2 Alternate Operations

The pumps share a common suction header for the primary clarifiers, primary clarifier scum tank, gravity thickener, and gravity thickener scum tank. As shown on **Figures 9-2** and **9-3**, the suction lines can be valved to dedicate a pump to a specific tank, or switch to a backup pump. Consequently, any of the four pumps can serve as a backup to the others.

The discharge lines for each pump are similarly configured. Each pump discharges vertically through a check valve and into a 3-way plug valve. The 3-way plug valve allows for discharge as follows:

- **West Header**: The west header is typically used for routing solids to the rotary screen thickener, the liquid solids loading port (near the primary clarifier scum tank), or the holding tank (used to feed the belt filter presses).

- **East Header:**
  - The east header is typically used for routing solids directly to the anaerobic digester.
  - Alternatively, the pumps can also discharge solids to the gravity thickener through the discharge line near Pump No. 5. If this operation is selected, the West Header would be used for feeding the anaerobic digester.
  - Last, the East Header can be used to pump back into a suction line. This can serve as a mechanism for back-flushing suction lines in the event they become plugged. It is not expected that this will be required frequently.

Ultimately, the discharge configuration is related to the solids management process that is preferred by the operators.

9.4 Troubleshooting of Rotary Lobe Pumps

NOTE: WHENEVER A PUMP STATUS OR FUNCTION IS TO BE CHANGED, IT IS IMPERATIVE THAT ALL PUMPS FIRST BE SWITCHED “OFF”. TURN PUMP SWITCHES AT MOTOR CONTROL CENTER AND ADJACENT TO THE PUMPS TO THE “OFF” POSITION, THEN PERFORM THE INTENDED MAINTENANCE.

Problem	Cause	Solution
Decrease of discharge pressure	1. Increased gap between rotor and rotor case or between the rotor	1. Check the state of pump case and rotor, change worn out components
	2. Erosion of rotor case	2. Dismantle and check the pump, change worn out elements, or have a manufacturer's overhaul
	3. Under-suction of air or unsealing in discharge piping	3. Check tightness of suction and discharge piping during the necessary sealing
	4. Leakiness of mechanical seals	4. Re-tighten or change mechanical seals
	5. Decreased rotation speed	5. Measure the number of revolutions, check voltage on supply lead of electric motor
	6. Faulty rotation direction	6. Check direction of rotation; change electric motor poles
	7. Pump filled improperly	7. Refill by taking into account that air is carefully eliminated
	8. Plugged suction piping	8. Check and clean suction piping
	9. Leakiness of suction valve	9. Check valve, clean if necessary
	10. Leakiness of suction piping	10. Check tightness of suction piping
	11. Low revolution number	11. Change rotation number, check voltage on the supply side of the electric motor

Problem	Cause	Solution
Decrease of flow	1. Increased gap between rotor and rotor case or between rotors	1. Check the pump and rotor case, change elements if in excessive worn out condition
	2. Direct consolidation of suction and discharge hole (erosion of rotor case)	2. Disassemble pump and check, replace damaged elements, or have a manufacturer's overhaul
	3. Under-suction of air or leakiness in discharge piping	3. Check suction and discharge piping sealing
	4. Leakiness of seals	4. Tighten or change seals
	5. Decreased number of revolutions	5. Measure number of revolutions, check voltage on supply of electric motor
	6. Choked suction piping	6. Check and clean suction piping
	7. Leakiness of suction piping	7. Check and seal suction piping
	8. Low rotation speed	8. Change revolution number, check voltage on supply of electric motor
	9. Suction height higher than the allowed	9. Reduce geometric height of suction, check and clean suction piping
Too large power is needed	1. Defects in the manufacturing of the drive motor	1. Check the motor and its power
	2. Viscosity of transport fluid is significantly higher than nominal	2. Increase (keep in mind the permitted) temperature of the transported fluid, install motor of larger power
	3. Knocking of rotor	3. Disassemble pump and check, replace damaged elements
	4. Mechanical seal is too tight	4. Check seal tightness and correct it
	5. Valve on the discharge piping is not opened fully	5. Open valve
	6. Discharge piping is choked or it is too long	6. Clean piping
Non-stable pump operation, pump noise	1. Height of suction larger than the allowed	1. Set to initial level in the piping, check suction piping and valve on suction piping, clean them if necessary
	2. Formation of steam in the pump	2. Decrease height of suction or increase pressure in the feeding tank
	3. Penetration of air into the pump through the suction line	3. Seal suction line, control the seal
	4. Characteristic worn out state of rotary elements and bearings	4. Dismantle pump, check rotating elements and bearings, and change them if necessary
	5. Very high flow or very small total head	5. Regulate pump operation by valve until noise disappears
	6. Increase of rotor knocking	6. Check rotor knocking

Problem	Cause	Solution
	7. Disturbed rotor balancing	7. Check rotor on the balancing base
	8. Coupling in de-balance or not even	8. Adjust or center the coupling
	9. De-centered rotor with drive unit	9. Center rotor and drive unit
Increased vibration of pump	1. Defect in base manufacturing	1. Change base, insulate base if necessary with cork or felt inserts
	2. Insufficient mounting of pump on the base	2. Retighten base bolts
	3. Vibration of piping	3. Eliminate vibration by additional pipe supports
Pump wears out quickly	1. Mixtures in transport fluid in front of suction piping	1. Clean piping
	2. Mixtures in transport fluid in front of discharge rotor	2. Take out the rotor and clean it
	3. Abrasive and aggressive mixtures	3. Check the material quality on resistance to transported fluid (by manufacturer)
	4. Stress of piping is transferred to pump	4. Change mounting to piping, providing isolation (flux couplings) of pumps without tightening
	5. Dry friction in bearings	5. Disassemble bearing, clean and reassemble, fill with new grease
	6. Insufficient flow of grease	6. Replace grease and gears, discharge grease, clean gearbox, and fill with clean grease

Chapter 10

Biosolids Handling: WAS Pumping

Chapter 10 – Biosolids Handling: WAS Pumping

10.1 General

RAS and WAS pumping are balanced in an activated sludge process to maintain sludge age and to remove waste solids from the system. Prior to the 2008-2010 upgrades the existing centrifugal WAS pumps made it difficult for the operators to control the amount of WAS that was being removed from the system. The 2008-2010 upgrades replaced the WAS pumps with rotary lobe (positive displacement) pumps, which allows the operators to move WAS and solids throughout the WWTP (i.e., to the rotary screen thickener, gravity thickener, or digester) while still maintaining a controlled flow rate at varying discharge pressures. The upgrades are shown on the M05 sheets included in the Record Drawings.

10.2 Waste Activated Sludge (WAS) Pumping

The need to waste excess sludge is affected by the plant loading, conversion of organics to biomass, temperature, settleability, and the quality of final effluent. The aeration basin(s) should be operated in a balanced state, with no appreciable change in biomass inventory from week to week. If no sludge is wasted, excessive biomass will accumulate in the process, which, if unchecked, can compromise the effectiveness of the biological treatment process (see Chapter 6 for further discussion on this issue).

The rate of sludge wasting will depend upon the inert solids in the raw waste and the amount of BOD removed and converted to new biomass. Solids should be wasted well before difficulties arise in the treatment plant or before the effluent is adversely affected. Additionally, solids should be wasted in order to satisfy a greater process goal (e.g., a desired SRT for the process, F:M ratio, or MLSS in the aeration basins). Setting a wasting rate without a specific outcome for one of these parameters will likely lead to widely ranging effluent quality as loads fluctuate and the biological process goes through common cycles of growth and decay.

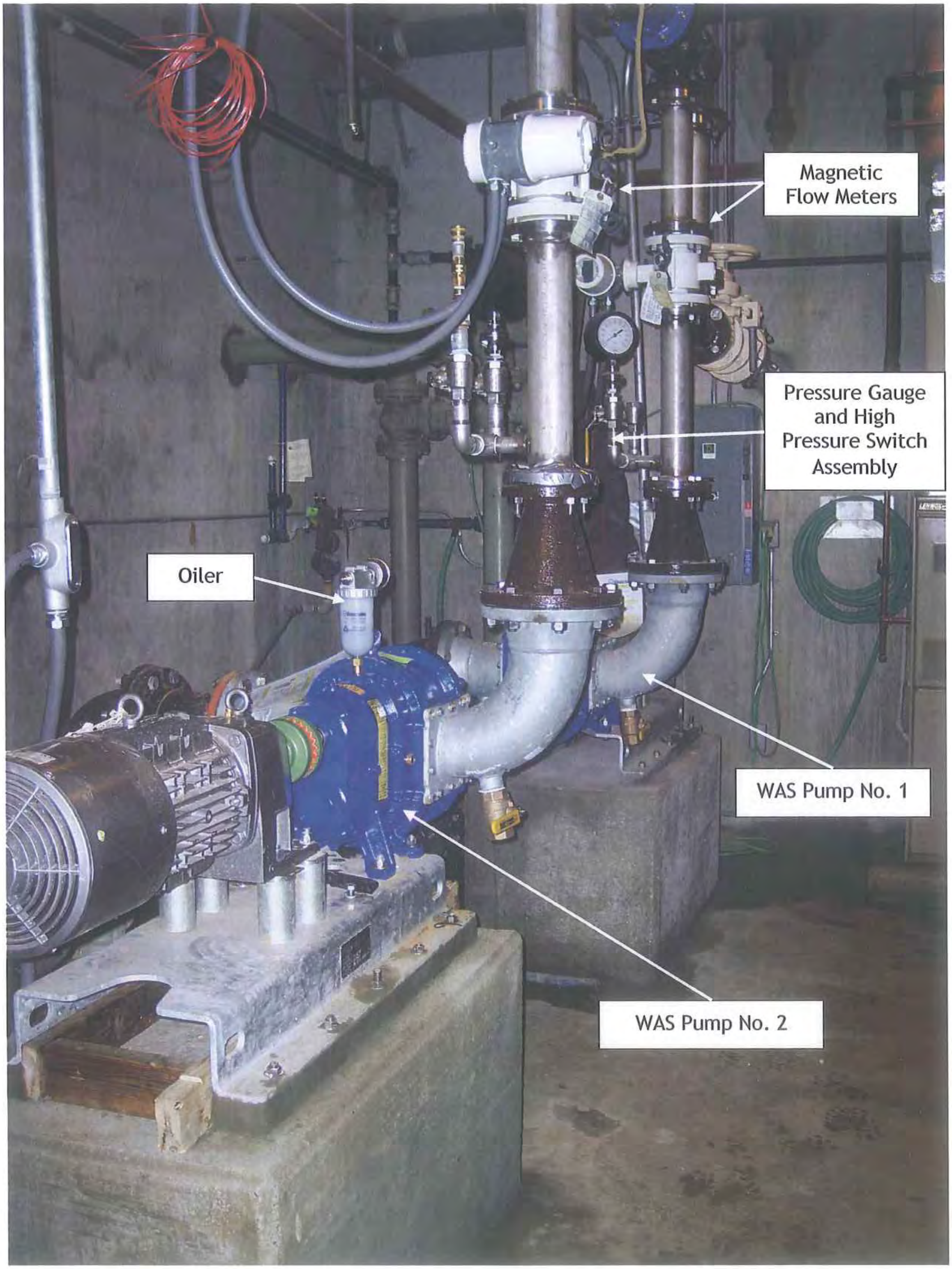
A timer with adjustable setting allows for periodic wasting using the WAS pumps from the clarifiers. The solids can be wasted directly to the anaerobic digester for further stabilization, sent to the rotary screen thickener for thickening prior to digestion, sent to the gravity thickener, or returned to the plant headworks. The alternative flow paths for the WAS will be discussed in conjunction with rotary screen thickener (RST) and gravity thickener operation in subsequent chapters.

The rotary lobe positive displacement WAS pumps were supplied by Correct Equipment Co. and manufactured by Vogelsang. These pumps are shown on **Figure 10-1**. The operator should refer to the manufacturer's O&M Manual for detailed operation and maintenance procedures. Contacts for the pumps are:

Vogelsang Pumps
Mark Thomas
7966 State Rt. 44
Ravenna, OH 44266
Phone: 330-296-3820

Correct Equipment, Inc. (Representative)
Steve Doyle
14576 NE 95th St.
Redmond, WA 98052
Phone: 425-869-1033
Cell: 425-466-2201
Fax: 425-869-1033

Figure 10-1 – WAS Pumps



10.3 WAS Pumping System Operation

10.3.1 Normal Operation

Under normal operating conditions, each pump pulls solids from a dedicated secondary clarifier and discharges to the downstream solids handling systems. The WAS pumps are designed to pump up to 300 gpm at 23 psi discharge pressure. Under normal operation, the pumps will pump at 100 gpm or less. The WAS pumps are normally operated in conjunction with the Rotary Screen Thickener (RST). Under this scenario, the WAS pumping rate is established to provide a desired sludge concentration from the RST. Since the RST cannot undergo startup operations, it is operated in a batch process.

10.3.2 Alternate Operations

The WAS pumps can also discharge solids as follows:

- Directly to the Anaerobic Digester: This option is typically not preferred due to the low solids concentration in the WAS (e.g., 0.5 to 1.0 percent). However, this option may be required if the RST is inoperable or undergoing maintenance.
- To the Gravity Thickener: This option would be utilized if the WAS pumps are operated in a batch mode and the RST is fed from the gravity thickener using the primary/transfer pumps (reference Chapter 11 for a detailed discussion of this option).

In either of these two operating schemes, the WAS pumps could operate on a duty cycle using a programmable timer (e.g., 3 minutes on and 15 minutes off). The pump speed can also be adjusted by adjusting the variable frequency drive speed either manually or through the plant PLC/SCADA.

Under these alternate operating conditions, valves must be configured manually. Depending on the WAS discharge location, valves may need to be adjusted at other processes also. For specifics, see the corresponding chapter in this O&M manual.

The WAS pumps can also pull from a common suction header and the alternate between lead and lag operation. This configuration can also be used if one pump is out of service.

10.4 Troubleshooting of Rotary Lobe Pumps

NOTE: WHENEVER A PUMP STATUS OR FUNCTION IS TO BE CHANGED, IT IS IMPERATIVE THAT ALL PUMPS FIRST BE SWITCHED “OFF”. TURN PUMP SWITCHES AT MOTOR CONTROL CENTER AND ADJACENT TO THE PUMPS TO THE “OFF” POSITION, THEN PERFORM THE INTENDED MAINTENANCE.

Problem	Cause	Solution
Decrease of discharge pressure	1. Increased gap between rotor and rotor case or between the rotor	1. Check the state of pump case and rotor, change worn out components
	2. Erosion of rotor case	2. Dismantle and check the pump, change worn out elements, or have a manufacturer's overhaul
	3. Under-suction of air or unsealing in discharge piping	3. Check tightness of suction and discharge piping during the necessary sealing
	4. Leakiness of mechanical seals	4. Re-tighten or change mechanical seals
Decrease of discharge pressure (continued)	5. Decreased rotation speed	5. Measure the number of revolutions, check voltage on supply lead of electric motor
	6. Faulty rotation direction	6. Check direction of rotation; change electric motor poles
	7. Pump filled improperly	7. Refill by taking into account that air is carefully eliminated
	8. Plugged suction piping	8. Check and clean suction piping
	9. Leakiness of suction valve	9. Check valve, clean if necessary
	10. Leakiness of suction piping	10. Check tightness of suction piping
	11. Low revolution number	11. Change rotation number, check voltage on the supply side of the electric motor
Decrease of flow	1. Increased gap between rotor and rotor case or between rotors	1. Check the pump and rotor case, change elements if in excessive worn out condition
	2. Direct consolidation of suction and discharge hole (erosion of rotor case)	2. Disassemble pump and check, replace damaged elements, or have a manufacturer's overhaul
	3. Under-suction of air or leakiness in discharge piping	3. Check suction and discharge piping sealing
	4. Leakiness of seals	4. Tighten or change seals
	5. Decreased number of revolutions	5. Measure number of revolutions, check voltage on supply of electric motor
	6. Choked suction piping	6. Check and clean suction piping
	7. Leakiness of suction piping	7. Check and seal suction piping
	8. Low rotation speed	8. Change revolution number, check voltage on supply of electric motor
	9. Suction height higher than the allowed	9. Reduce geometric height of suction, check and clean suction piping
Too large power is needed	1. Defects in the manufacturing of the drive motor	1. Check the motor and its power

Problem	Cause	Solution
	2. Viscosity of transport fluid is significantly higher than nominal	2. Increase (keep in mind the permitted) temperature of the transported fluid, install motor of larger power
	3. Knocking of rotor	3. Disassemble pump and check, replace damaged elements
	4. Mechanical seal is too tight	4. Check seal tightness and correct it
	5. Valve on the discharge piping is not opened fully	5. Open valve
	6. Discharge piping is choked or it is too long	6. Clean piping
Non-stable pump operation, pump noise	1. Height of suction larger than the allowed	1. Set to initial level in the piping, check suction piping and valve on suction piping, clean them if necessary
	2. Formation of steam in the pump	2. Decrease height of suction or increase pressure in the feeding tank
	3. Penetration of air into the pump through the suction line	3. Seal suction line, control the seal
	4. Characteristic worn out state of rotary elements and bearings	4. Dismantle pump, check rotating elements and bearings, and change them if necessary
	5. Very high flow or very small total head	5. Regulate pump operation by valve until noise disappears
	6. Increase of rotor knocking	6. Check rotor knocking
	7. Disturbed rotor balancing	7. Check rotor on the balancing base
	8. Coupling in de-balance or not even	8. Adjust or center the coupling
	9. De-centered rotor with drive unit	9. Center rotor and drive unit
Increased vibration of pump	1. Defect in base manufacturing	1. Change base, insulate base if necessary with cork or felt inserts
	2. Insufficient mounting of pump on the base	2. Retighten base bolts
	3. Vibration of piping	3. Eliminate vibration by additional pipe supports
Pump wears out quickly	1. Mixtures in transport fluid in front of suction piping	1. Clean piping
	2. Mixtures in transport fluid in front of discharge rotor	2. Take out the rotor and clean it
	3. Abrasive and aggressive mixtures	3. Check the material quality on resistance to transported fluid (by manufacturer)
	4. Stress of piping is transferred to pump	4. Change mounting to piping, providing isolation (flux couplings) of pumps without tightening

Problem	Cause	Solution
	5. Dry friction in bearings	5. Disassemble bearing, clean and reassemble, fill with new grease
	6. Insufficient flow of grease	6. Replace grease and gears, discharge grease, clean gearbox, and fill with clean grease

Chapter 11

Biosolids Handling: Solids Thickening

Chapter 11 – Biosolids Handling: Solids Thickening

11.1 General

The 2008-2010 WWTP Upgrades added additional thickening capabilities with a rotary screen thickener (RST) and related components. The M05-sheets included in the record drawings show the new systems. The RST allows for additional operational flexibility for solids thickening and is intended to improve the anaerobic digester. The biosolids handling system consists of the following components:

- Gravity Thickener - This chapter
- Rotary Screen Thickener (RST) - This chapter
- Secondary RAS Pumps - See Chapter 7
- Primary Sludge Transfer Pumps - See Chapter 9
- Secondary WAS Pumps - See Chapter 10
- Anaerobic Biosolids Digester - See Chapter 12
- Belt Filter Press - See Chapter 13

It is desirable to thicken waste activated sludge (solids) prior to treatment in the anaerobic digester for two reasons. First, reducing the water in the solids results in a lower volumetric loading. This results in a longer hydraulic residence time in the digester and allows for greater volatile solids reduction. Second, reducing the amount of water entering the digester means less water must be heated with each wasting cycle to the digester. The heat transfer system can therefore keep the digester contents at the desired level more easily using less energy. A target for solids entering the anaerobic digester is 4 to 6 percent. To achieve these solids levels, the RST will be required.

Thickening for the Sandpoint WWTP can occur with three different methods:

- Gravity thickening
- Rotary screen thickener
- Combination of both

11.2 Gravity Thickener

The gravity thickener, built in 1973, can receive one or all of the following:

- Primary sludge from the primary clarifiers
- WAS from the secondary clarifiers
- Scum from the primary and secondary clarifiers

The purpose of the gravity thickener is to increase the concentration of solids entering the digester by allowing solids to settle into a hopper. Supernatant, or overflow, returns downstream of the influent Parshall flume. Under normal conditions, the gravity thickener will likely thicken WAS to 0.5 to 1.0 percent. Primary solids may undergo some thickening, but the overflow rate will result in less efficient thickening, which has historically resulted in diluting both process streams. The gravity thickener is also a dominant source of odors at the facility.

Figure 11-1 shows the gravity thickener and **Table 11-1** summarizes specific information related to the equipment.

Figure 11-1 – Gravity Thickener

Table 11-1 - Gravity Thickener Summary

Item	Gravity Thickener	Recommended Range	Units
Diameter	16		feet
Area	201		square feet
Hydraulic Loading	270 [a]	100-200 (WAS)	gpd/sf
	316 [b]	380-760 (primary solids)	
Solids Loading	19 [a]	5-14	lb/(sf-day)
	22 [b]		
Construction Material	concrete		
Volume	15,800		gallons
Depth	10.5		feet
Bottom Slope	2.75:12	2:12 to 3:12	vertical rise: horizontal run

[a] *Average day*

[b] *Daily load during a peak month event*

11.3 Rotary Screen Thickening System

The rotary screen thickener (RST) was added as part of the 2008-2010 upgrades to more efficiently thicken solids prior to entering the anaerobic digester. The RST system consists of the following components:

- Polymer Feed System
- Flocculation Tank
- Rotary Screen Thickener
- Thickened Solids Pump
- Control Equipment

Photographs of the Rotary Screen Thickening System are included for visual reference on **Figures 11-2** through **11-6**.

11.3.1 RST Polymer Feed System

Polymer added to the sludge flow stream enhances the sludge dewatering system capabilities. The polymer feed piping and pumping for the rotary screen thickening system was added to the existing polymer feed system for the belt filter presses with the 2008-2010 upgrades. The existing polymer mixing tank and day tank are currently utilized to mix polymer in solution for Belt Filter Press 1, Belt Filter Press 2, and the new rotary screen thickener. The majority of the system piping and pumping is located in the lower level of the Belt Filter Press Building.

Either of the two polymer metering pumps pull mixed polymer solution off the downstream side of the polymer day tank. The pumps transfer polymer solution to the inline mixer upstream of the RST flocculation tank. The polymer metering pumps are Grundfos Model DME 150-4. The operator should refer to the manufacturer's O&M Manual provided by the contractor prepared for the 2008-2010 Sandpoint Wastewater Treatment Plant Upgrades for detailed operation and maintenance procedures. A photo of the polymer injector and mixer is shown on **Figure 11-1**. Contact information for the pumps is as follows:

Grundfos Pump Corporation
2270 Northwest Parkway
Suite 180
Marietta, Georgia 30067
Phone: 770-956-7996
Fax: 770-956-7836

Preferred Pump
11303 Montgomery Drive, 4
Spokane, WA 99206
Phone: 425-869-1033
Phone: 800-588-8213
Fax: 509-891-4367

11.3.2 RST Flocculation Tank

The RST flocculation tank is located adjacent to the RST in the Solids Thickening Building. The design intent of the flocculation tank is to condition the sludge with polymer prior to thickening. With the proper combination of polymer mixing and retention time, the sludge and polymer will flocculate prior to entering the RST, which enhances thickening operations.

The flocculation tank consists of a tank with the sludge/polymer inlet on the bottom and conditioned sludge overflow on one side near the top. A variable speed, top-mounted agitator for controlled mixing of the sludge and polymer provides mixing. The mechanical speed variator allows for agitator speed adjustment manually.

Figure 11-2 – Polymer Injector and Mixer

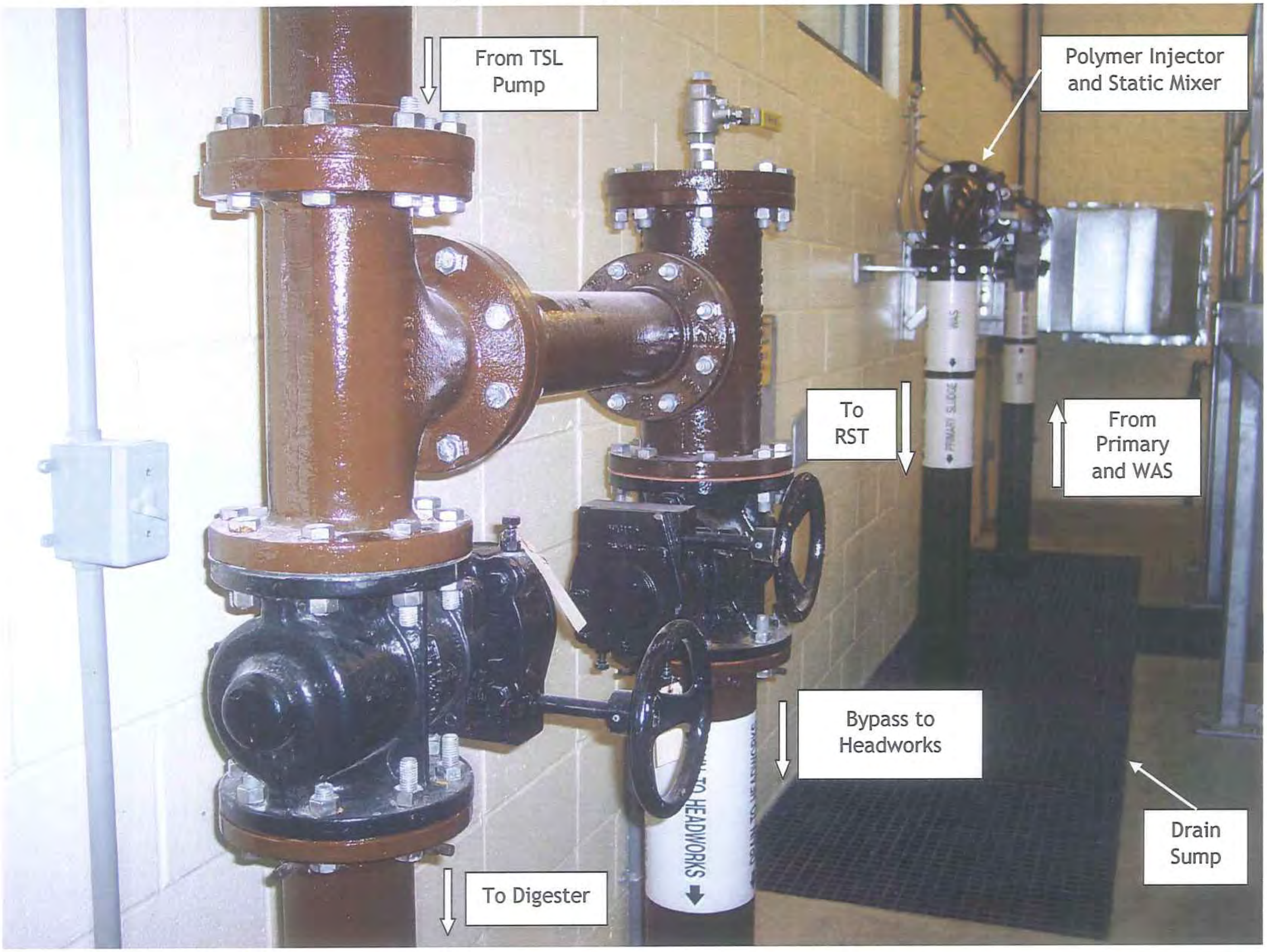


Figure 11-3 – RST Polymer Feed System for RST (in Dewatering Building)

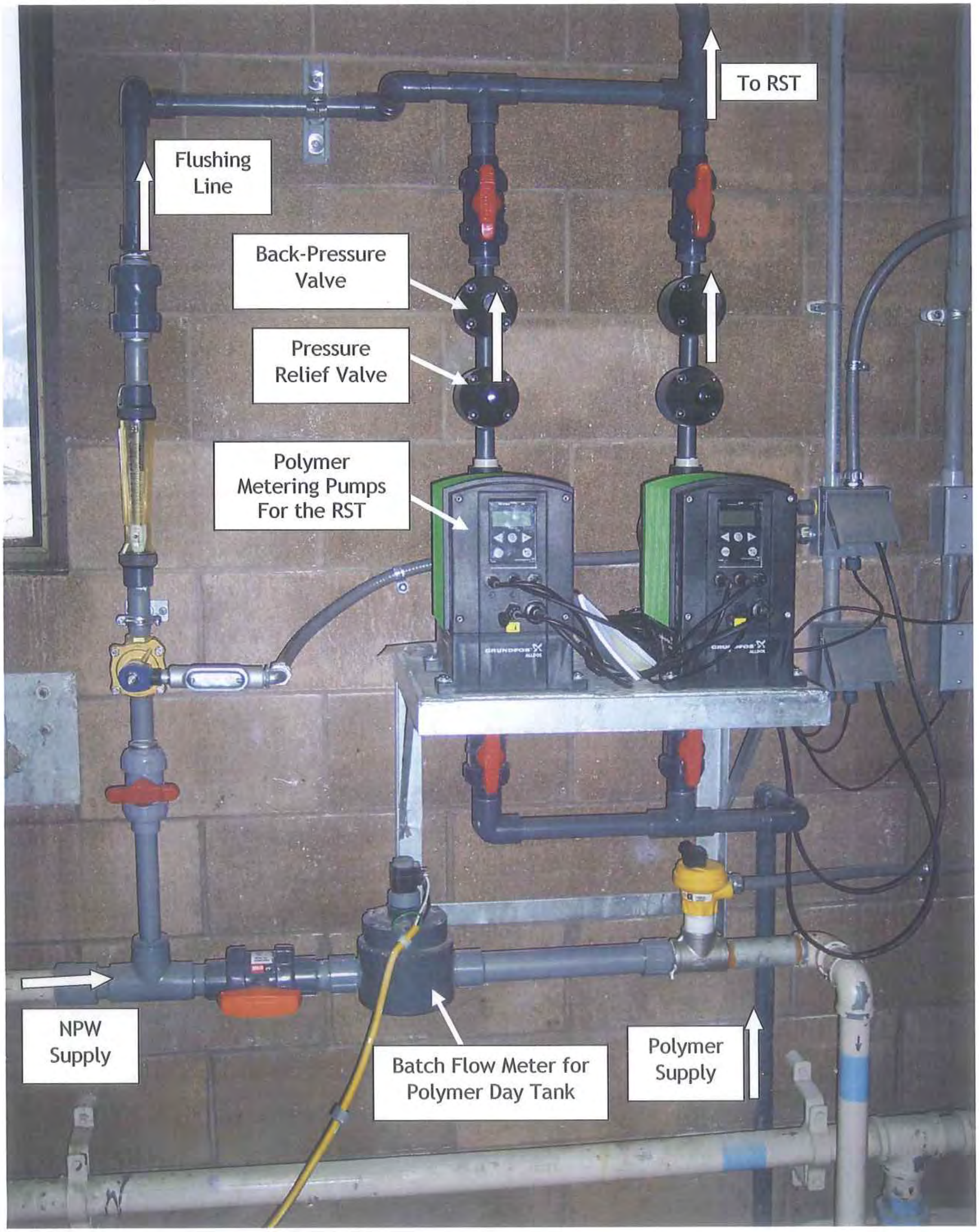


Figure 11-4 – Rotary Screen Thickener

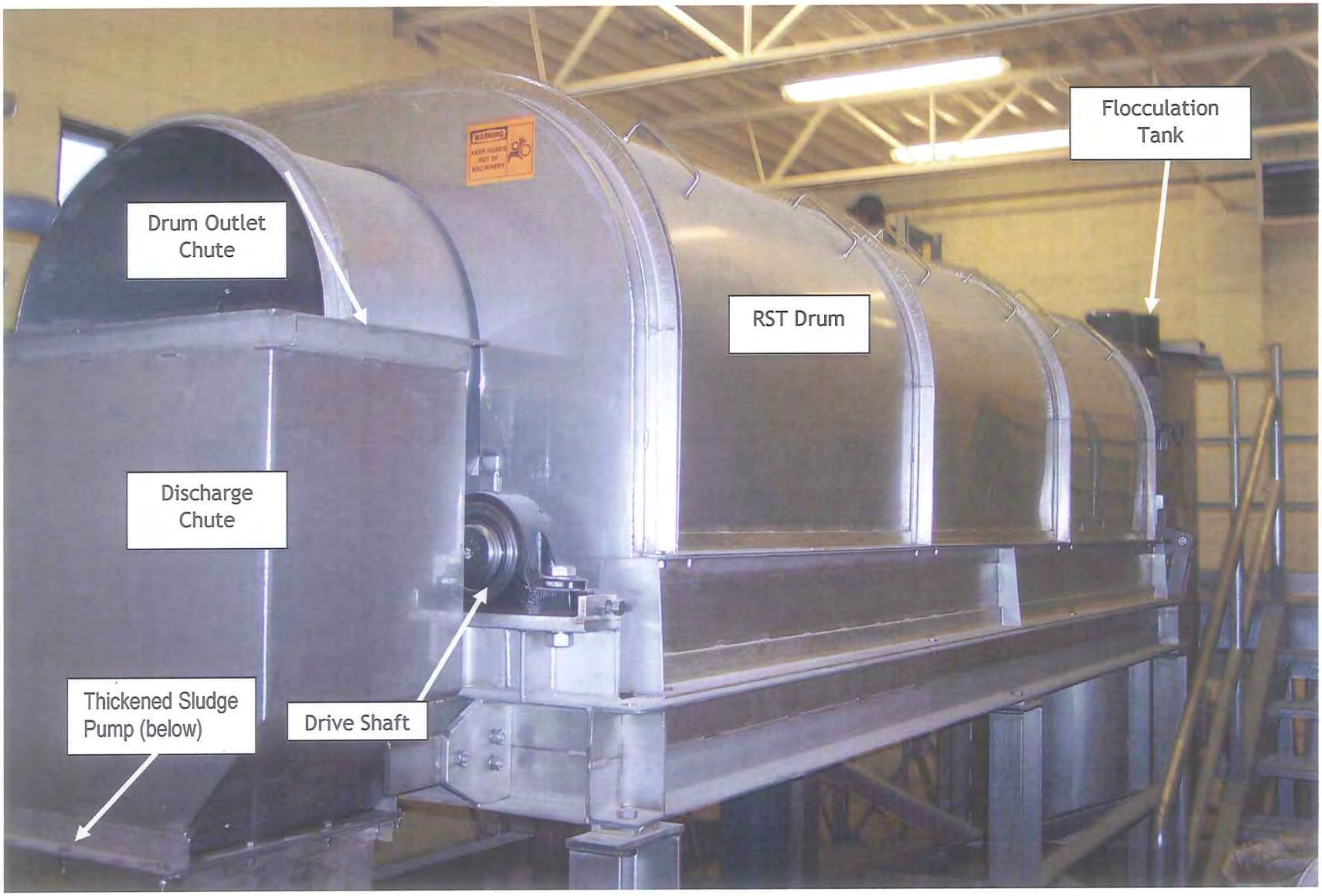


Figure 11-5 – Rotary Screen Thickener and TSL Pump

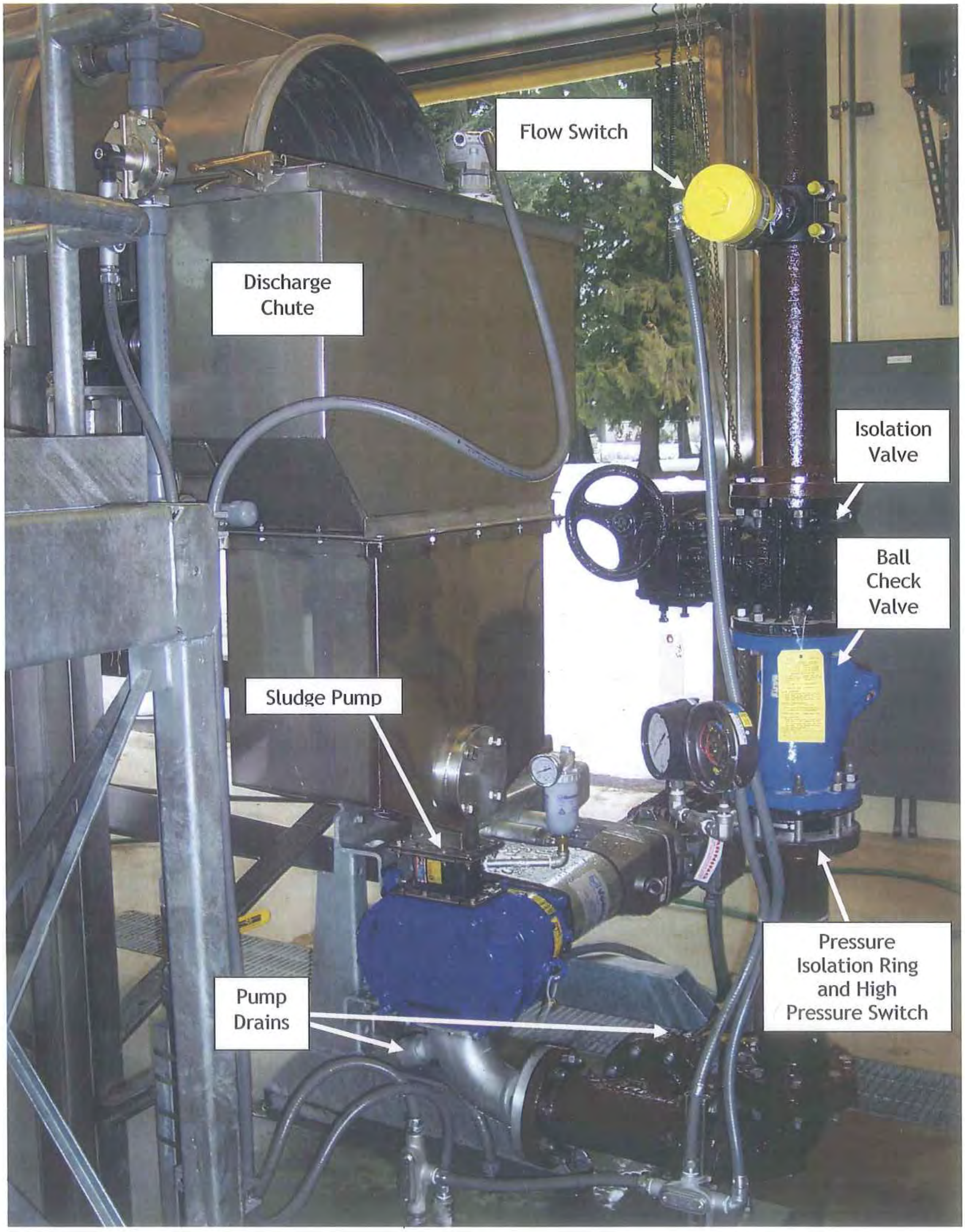
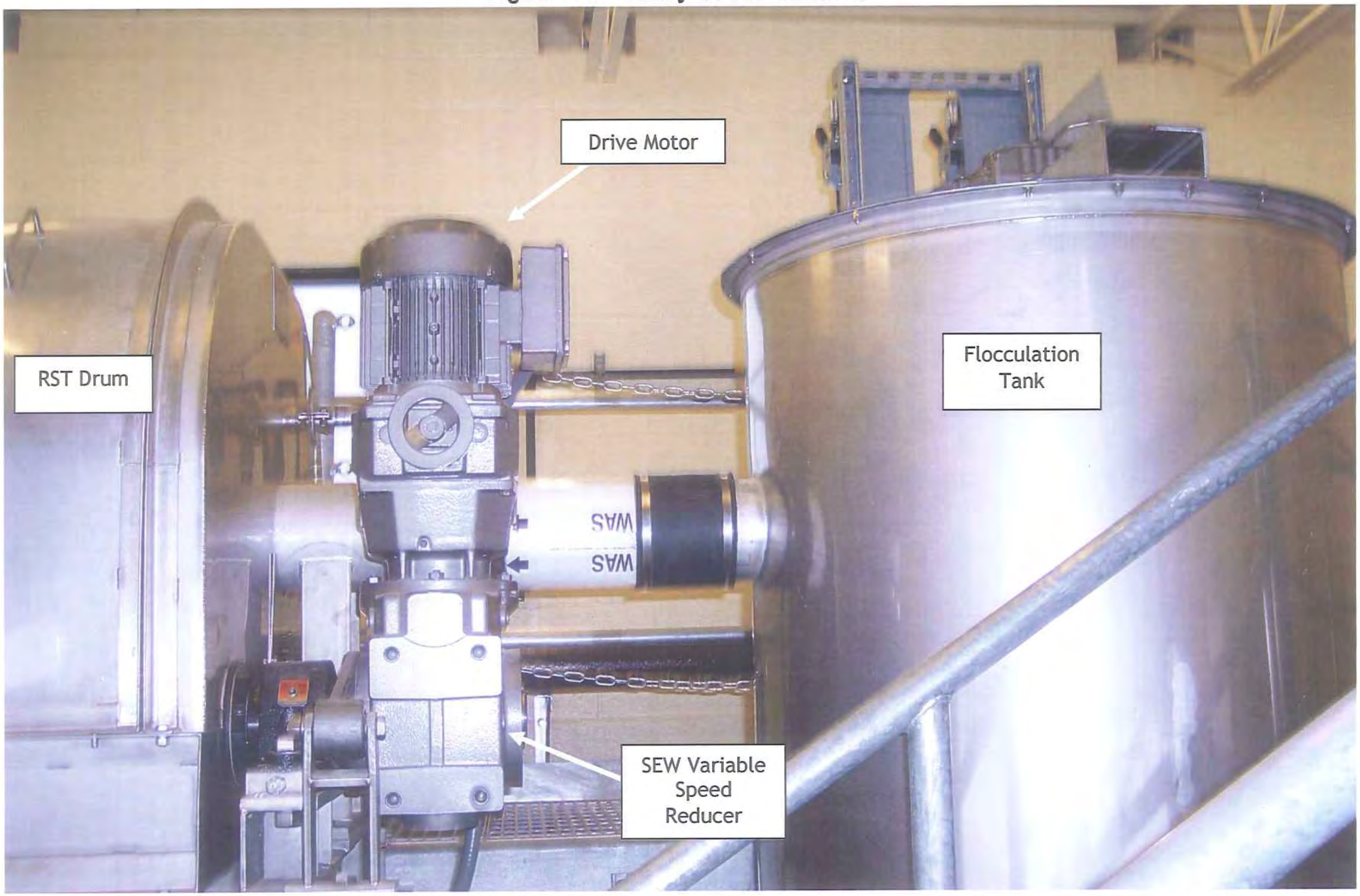


Figure 11-6 – Rotary Screen Thickener



Startup of the flocculation tank is as follows:

- Startup of the flocculation tank shall occur in conjunction with the rotary screen thickener.
- The axial vane impellers should force the sludge downwards towards the sludge inlet to provide for proper mixing of the sludge polymer.
- Begin polymer flow. Begin sludge flow.

Shut down of the flocculation tank is as follows:

- Stop sludge flow, polymer flow, and the tank agitator motor.
- Drain the flocculation tank if the sludge dewatering system will be shut down for a week or more.

Optimal sludge conditioning involves minimizing polymer costs while producing a flocculated sludge that can be mechanically dewatered by the equipment that follows. The flocculation tank is the last element of the sludge conditioning system. Properly conditioned sludge will have an appearance of runny cottage cheese.

Factors affecting the performance of the sludge conditioning system include:

- Polymer type
- Polymer age
- Polymer injection point locations

<u>Flocculation Tank Maintenance</u>

- The oil level and quality in the agitator drive should be checked weekly.
- Drain and clean the flocculation tank every three months to determine if buildup is occurring. Increase time between cleanings if buildup of sludge material is not occurring.

11.3.3 Rotary Screen Thickener

The design intent of the RST is to continuously or intermittently receive, flocculate, condition, and sludge, ultimately discharging thickened sludge to the anaerobic digester. The unit is manufactured by FKC and represented by Pedroni and Co. The operator should refer to the manufacturer's O&M Manual provided by the contractor prepared for the 2008-2010 Sandpoint Wastewater Treatment Plant Upgrades for detailed operation and maintenance procedures. The contact information regarding the RST appears below:

FKC CO., LTD
Wes Bond
2708 West 18th Street
Port Angeles, WA 98363
Phone: 360-452-9472
Fax: 360-452-6880
Email: mail@fkcscrewpress.com

Pedroni & Co.
Victor Pedroni
4580 Klahanie Dr. SE #271
Issaquah, WA 98027
Phone: 425-369-6164
Fax: 425-963-8600
Email: victor@pedroni-co.com

The unit consists of a rotating drum through which the sludge flows. The drum is lined with a perforated stainless steel screen, allowing the free draining liquids in the conditioned sludge to be removed. Two shafts support the drum, which is coupled to a mechanical variable speed drive. The free draining liquid from the conditioned sludge, or filtrate, is collected in a "filter basin" below the drum and funneled to a discharge pipe that returns the filtrate downstream of the influent Parshall flume.

The RST contains the following components and features:

- 20 gage perforated stainless steel screens with 0.045-inch-diameter holes and 23 percent open area.
- The drums are supported and driven by full-length polyurethane coated shafts with 17-4 stainless stub ends.
- The shafts are supported on each end with 3-inch spherical roller pillow block bearings mounted outside the "wet environment."
- A shower header for washing the exterior screen surface. The shower header is used to spray water on the exterior of the rotating screen to dislodge sludge particles that could be blinding the screen from the inside. The screen holes must be kept clear for the RST to function properly.
- Stainless steel covers and discharge chute.

Table 11-2 shows the intended operation and performance of the RST:

Table 11-2 - RST Intended Operation

Influent feed dry solids concentration	0.5 to 3.0%
Source of sludge to be concentrated	Waste activated sludge (WAS) or WAS with primary solids
Feed sludge temperature	40 to 95° F
Feed sludge pH	5 to 8
Washwater	Non-potable wastewater treatment plant effluent
Conditioning	Emulsion or dispersion polymer only
Cake solids concentration, dry weight, percent total solids	4-8% Target of 6%
Minimum overall solids capture, percent	98
Maximum polymer dosage, pounds of 100% active polymer per ton of dry feed solids	9
Maximum Hydraulic loading, gallons per minute WAS (feed at 0.5% total solids)	150
Total solids loading, pounds of sludge, feed dry solids per hour at 0.5% total solids	750

Startup of the RST is performed as follows:

- The RST should be empty from previous shutdown.
- Start the RST drum.

- Open the shower header water supply valve. Adjust the shower water flow by throttling the valve.
- Begin polymer injection and sludge flow through the floc tank; condition the sludge.
- Adjust the speed of the RST drum by turning the hand wheel on the speed reducer.

Optimize Performance of the RST as follows:

- Drum Speed Adjustment:
  - The operator may adjust the drum speed from approximately 0.84 to 4.34 rpm. Normally, a midrange speed of 2.1 rpm is recommended (this corresponds to a 0.5 setting on the Varimot Eurodrive, or 50 percent of full speed.
  - If the speed setting is increased, the effective open area of the drum screen increases, resulting in more drainage (if possible) and a higher sludge concentration. One disadvantage of higher drum speeds is possible damage to the flocculated sludge particles due to increased turbulence, which results in lower capture rates (i.e., more solids are lost in the filtrate and are returned to the headworks). Another disadvantage to higher drum speeds is that mechanical wear increases as the drum speed increases.
  - The goal is to remove as much of the free draining liquid at the lowest rpm possible.
- Vary the Shower-Header Water Pressure:
  - Typically, a range of 10 to 40 psi water pressure is most effective.
  - Adjust the pressure to keep screens clear but avoid excessive pressure.
  - Excessive pressure results in excessive amounts of water spraying through the screens and re-entering the sludge.

<u>Shutdown</u>

- Stop the sludge feed to the RST.
- Allow the RST to run until cake is no longer discharging.
- Close the shower header water supply valve.
- Stop the RST.
- Optional: Drain the floc tank. This may be desirous to minimize odors.

The startup and shutdown procedures are pre-programmed into the PLC that controls the system.

<u>Maintenance</u>

The manufacturer's O&M manual has several weekly maintenance items as well as bi-annual inspection. The recommended maintenance is as follows:

- There are four pillow block bearings supporting the shafts on the single drum RST. Lubricate these pillow block bearings with a good quality, lithium base, EP1 consistency grease on a weekly basis.

- Inspect the oil levels on the SEW Eurodrive reducer. Lubricate as recommended in the SEW manuals, bound separately.
- Inspect the shower header nozzles and clean plugged screen holes.

Solids Capture

Solids capture is the percent of the feed solids that remain in the dewatered end product on a weight basis. For purposes of this system, "capture" is defined as:

Equation 10.2.2.3

$$\%Capture = \frac{C}{F} \times \frac{(F-E)}{(C-E)} \times 100$$

Where:

C	=	Thickened Sludge Total Solids (% TS)
F	=	Feed (% TSS), excluding any dilution from polymer solution flow
E	=	Filtrate (% TSS), excluding any dilution from polymer solution and wash water flows

11.3.4 RST Thickened Solids Pump (TSL Pump)

11.3.4.1 General

The RST thickened solids pump conveys thickened solids from the RST to the anaerobic digester. The pump is a rotary lobe (positive displacement) pump manufactured by Vogelsang (Model VX136-70Q) and represented by Correct Equipment. The operator should refer to the manufacturer's O&M Manual provided by the contractor prepared for the 2008-2010 Sandpoint Wastewater Treatment Plant Upgrades for detailed operation and maintenance procedures. The contact information regarding the thickened solids pumps is as follows:

Vogelsang Pumps
Mark Thomas
7966 State Rt. 44
Ravenna, OH 44266
Phone: 330-296-3820

Correct Equipment Inc. (Representative)
Steve Doyle
14576 NE 95th St.
Redmond, WA 98052
Phone: 425-869-1033
Cell: 425-466-2201
Fax: 425-869-1033

11.3.4.2 TSL Pump Intended Operation

The TSL pump is fed by solids leaving the RST that fall into the RST discharge chute/TSL feed hopper. The TSL pump operates on a VFD to maintain a consistent level in the hopper. The pump is intended to pump up to 200 gpm at 27 psi. The TSL pump is designed to pump solids concentrations up to approximately 8 percent solids. Concentrations above 8 percent have resulted in dramatically increased pump discharge pressures to the anaerobic digester, causing the pump to over-amp or over-pressure and shut down. The pump is fitted with a high pressure switch set at 30 psi. The pump is fitted with a ball-check valve and motor brake to prevent backflow from the digester or from the primary/transfer solids pumps since they use a common feed line to the digester.

11.3.4.3 Troubleshooting the TSL Pump

Problem	Cause	Solution
Decrease of discharge pressure	1. Increased gap between rotor and rotor case or between the rotor	1. Check the state of pump case and rotor, change worn out components
	2. Direct consolidation of suction and discharge hole (erosion of rotor case)	2. Dismantle and check the pump, change worn out elements, or have a manufacturer's overhaul
	3. Under-suction of air or unsealing in discharge piping	3. Check tightness of suction and discharge piping during the necessary sealing
	4. Leakiness of mechanical seals	4. Re-tighten or change mechanical seals
	5. Decreased rotation speed	5. Measure the number of revolutions, check voltage on supply lead of electric motor
	6. Faulty rotation direction	6. Check direction of rotation; change electric motor poles
	7. Pump filled improperly	7. Refill by taking into account that air is carefully eliminated
	8. Plugged suction piping	8. Check and clean suction piping
	9. Leakiness of suction valve	9. Check valve, clean if necessary
	10. Leakiness of suction piping	10. Check tightness of suction piping
	11. Low revolution number	11. Change rotation number, check voltage on the supply side of the electric motor
Decrease of flow	1. Increased gap between rotor and rotor case or between rotors	1. Check the pump and rotor case, change elements if in excessive worn out condition
	2. Direct consolidation of suction and discharge hole (erosion of rotor case)	2. Disassemble pump and check, replace damaged elements, or have a manufacturer's overhaul
	3. Under-suction of air or leakiness in discharge piping	3. Check suction and discharge piping sealing
	4. Leakiness of seals	4. Tighten or change seals
	5. Decreased number of revolutions	5. Measure number of revolutions, check voltage on supply of electric motor
	6. Choked suction piping	6. Check and clean suction piping
	7. Leakiness of suction piping	7. Check and seal suction piping
	8. Low rotation speed	8. Change revolution number, check voltage on supply of electric motor
	9. Suction height higher than the allowed	9. Reduce geometric height of suction, check and clean suction piping
Too large power is needed	1. Defects in the manufacturing of the drive motor	1. Check the motor and its power
	2. Viscosity of transport fluid is significantly higher than nominal	2. Increase (keep in mind the permitted) temperature of the transported fluid,

Problem	Cause	Solution
		install motor of larger power
	3. Knocking of rotor	3. Disassemble pump and check, replace damaged elements
	4. Mechanical seal is too tight	4. Check seal tightness and correct it
	5. Valve on the discharge piping is not opened fully	5. Open valve
	6. Discharge piping is choked or it is too long	6. Clean piping
Non-stable pump operation, pump noise	1. Height of suction larger than the allowed	1. Set to initial level in the piping, check suction piping and valve on suction piping, clean them if necessary
	2. Formation of steam in the pump	2. Decrease height of suction or increase pressure in the feeding tank
	3. Penetration of air into the pump through the suction line	3. Seal suction line, control the seal
	4. Characteristic worn out state of rotary elements and bearings	4. Dismantle pump, check rotating elements and bearings, and change them if necessary
	5. Very high flow or very small total head	5. Regulate pump operation by valve until noise disappears
	6. Increase of rotor knocking	6. Check rotor knocking
	7. Disturbed rotor balancing	7. Check rotor on the balancing base
	8. Coupling in de-balance or not even	8. Adjust or center the coupling
	9. De-centered rotor with drive unit	9. Center rotor and drive unit
Increased vibration of pump	1. Defect in base manufacturing	1. Change base, insulate base if necessary with cork or felt inserts
	2. Insufficient mounting of pump on the base	2. Retighten base bolts
	3. Vibration of piping	3. Eliminate vibration by additional pipe supports
Pump wears out quickly	1. Mixtures in transport fluid in front of suction piping	1. Clean piping
	2. Mixtures in transport fluid in front of discharge rotor	2. Take out the rotor and clean it
	3. Abrasive and aggressive mixtures	3. Check the material quality on resistance to transported fluid (by manufacturer)
	4. Stress of piping is transferred to pump	4. Change mounting to piping, providing isolation (flux couplings) of pumps without tightening
	5. Dry friction in bearings	5. Disassemble bearing, clean and reassemble, fill with new grease
	6. Insufficient flow of grease	6. Replace grease and gears, discharge grease, clean gearbox, and fill with clean grease

11.4 Solids Thickening System Operation

Several operation schemes are possible for the solids thickening system. This section focuses of the four preferred thickening options but mentions four additional manual operational modes, which are possible but will not likely be used. The thickening options appear in **Table 11-3** below.

Table 11-3 - Solids Thickening System Options

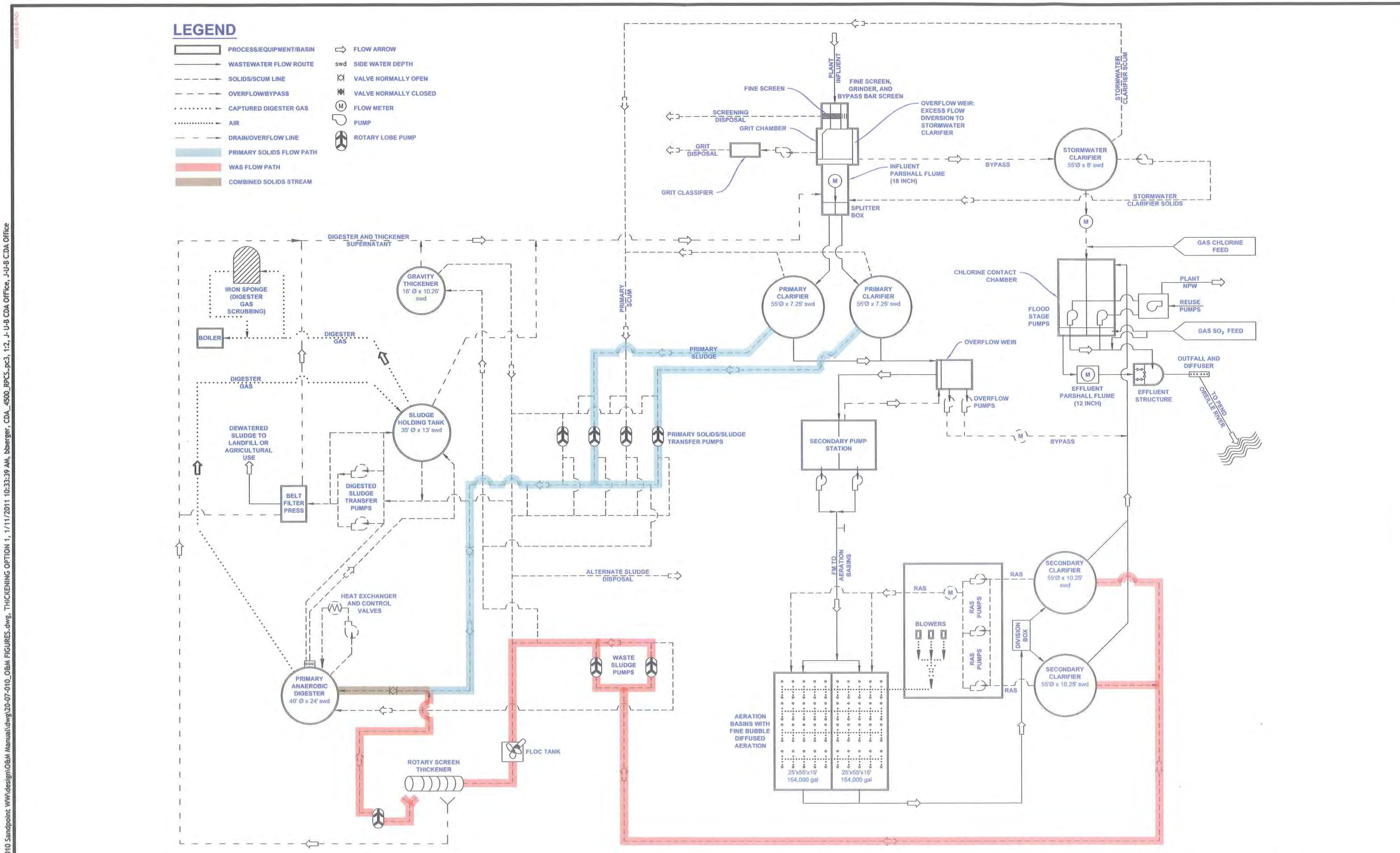
Thickening Option	Solids	Gravity Thickener	RST	Anaerobic Digester
1	Primary Solids			X
	WAS		X	X
2	Primary Solids			X
	WAS	X	X	X
3	Primary Solids	X	X	X
	WAS	X	X	X
4	Primary Solids	X		X
	WAS	X		X
5	Primary Solids		X	X
	WAS		X	X
6	Primary Solids	X		X
	WAS		X	X
7	Primary Solids		X	X
	WAS	X		X
8	Primary Solids		X	X
	WAS	X		X

Routing solids within the WWTP involves a network of individual, manually-operated valves that must be used together to prevent accidental discharges of pumping against a closed valve. Because the thickening processes receive solids from various areas of the facility, the reader is referred to the individual chapters of this O&M Manual for specifics in each process area. Several of the thickening options are discussed in subsequent sections.

11.4.1 Thickening Option 1

Thickening Option 1 appears schematically on **Figure 11-7** and includes the following:

- Primary solids routed directly to the anaerobic digester
- WAS from the secondary clarifier routed to the RST and then to the anaerobic digester.



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J-U-B

J-U-B ENGINEERS, Inc.

CAD FILE: 20-07-010_O&M FIGURES

CITY OF SANDPOINT
WASTEWATER TREATMENT PLANT O&M

THICKENING OPTION NO. 1
FIGURE 11-7

The control logic for this option consists of the following:

- Primary solids pumps operate on a timer with the following programmable user set points to draw from the primary clarifier and feed to the anaerobic digester.
    - Programmable set time for pumps to run
    - Programmable set time for pumps off
- The RST shall be set to operate in duty cycle. This operation requires communication between the RST and the WAS pumps and a WAS feed rate to the RST. The WAS pump speed will be based on a user adjustable flow rate (or volume) and time input.

11.4.2 Thickening Option 2

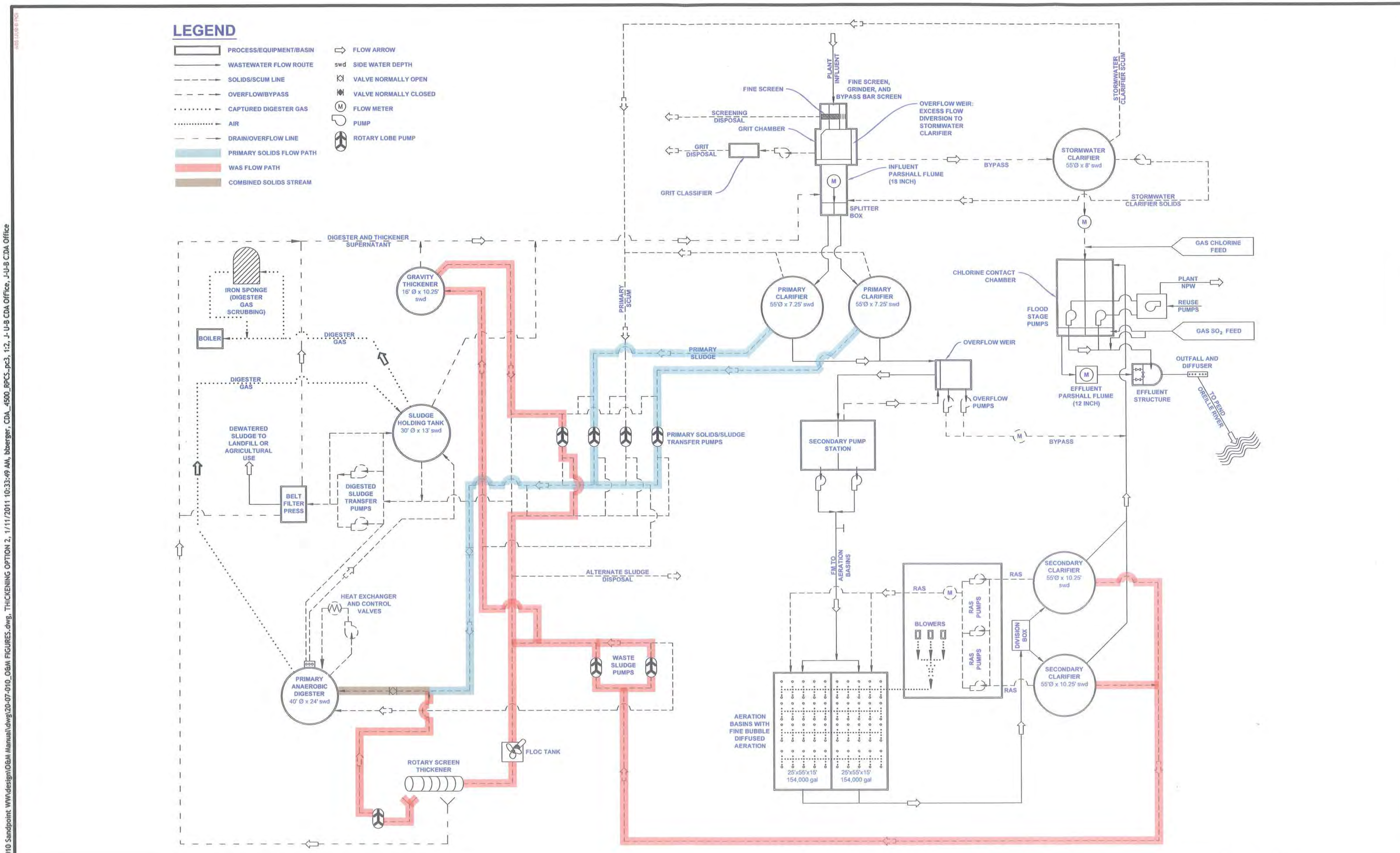
Thickening Option 2 appears schematically on **Figure 11-8** and includes the following:

- Primary solids routed directly to the anaerobic digester
- WAS from the secondary clarifier is pumped to the gravity thickener, then re-pumped to the RST with the sludge transfer pumps, and thickened solids are sent to the digester

The control logic for this option consists of the following:

- The primary solids pumps operate on a timer with the following programmable user set points to draw from the primary clarifier and feed to the anaerobic digester:
    - Programmable set time for pumps to run
    - Programmable set time for pumps off
- The secondary WAS pumps will operate on a timer with the following programmable user set points to draw from the secondary clarifier and feed the gravity thickener:
    - Duty time for pumps on/off
    - VFD speed or pumping rate
- The RST shall be set to operate in batch mode. This operation will communicate with the level monitor in the gravity thickener. When the level in the gravity thickener reaches a programmable "high level," operation of the RST in batch mode will begin. This operation requires communication between the RST and the sludge transfer pumps via 4-20 Ma signal to provide a required WAS feed rate from the sludge transfer pumps when required by the RST. The RST will operate until the level in the gravity thickener reaches the programmable "low level" off set point.

This option has the potential to create odors from WAS in the gravity thickener. Care should be exercised to minimize odor generation and overflowing material to the primary clarifiers, which can spread the odor problem.



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CAD FILE: 20-07-010_O&M FIGURES

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CITY OF SANDPOINT
WASTEWATER TREATMENT PLANT O&M

THICKENING OPTION NO. 2
FIGURE 11-8

11.4.3 Thickening Option 3

Thickening Option 3 appears schematically on **Figure 11-9** and involves co-thickening of primary and waste activated solids in the RST. Both settled solids from the primary clarifier and WAS from the secondary clarifiers are routed to the gravity thickener, to the RST, and finally to the anaerobic digester.

The control logic for this option consists of the following:

- The primary solids pumps operate on a timer with the following programmable user set points to draw from the primary clarifier and feed to the gravity thickener:
    - Duty time for pumps on/off
    - VFD speed or pumping rate
- The secondary WAS pumps operate on a timer with the following programmable user set points to draw from the secondary clarifier and feed the gravity thickener:
    - Duty time for pumps on/off
    - VFD speed or pumping rate
- The RST shall be set to operate in batch mode. This operation will communicate with the level monitor in the gravity thickener. When the level in the gravity thickener reaches a programmable level, operation of the RST in batch mode will begin. This operation requires communication between the RST and the sludge transfer pumps via 4-20 Ma signal to provide a required feed rate from the sludge transfer pumps when required by the RST. The RST will operate until the level in the gravity thickener reaches the programmable level for off.

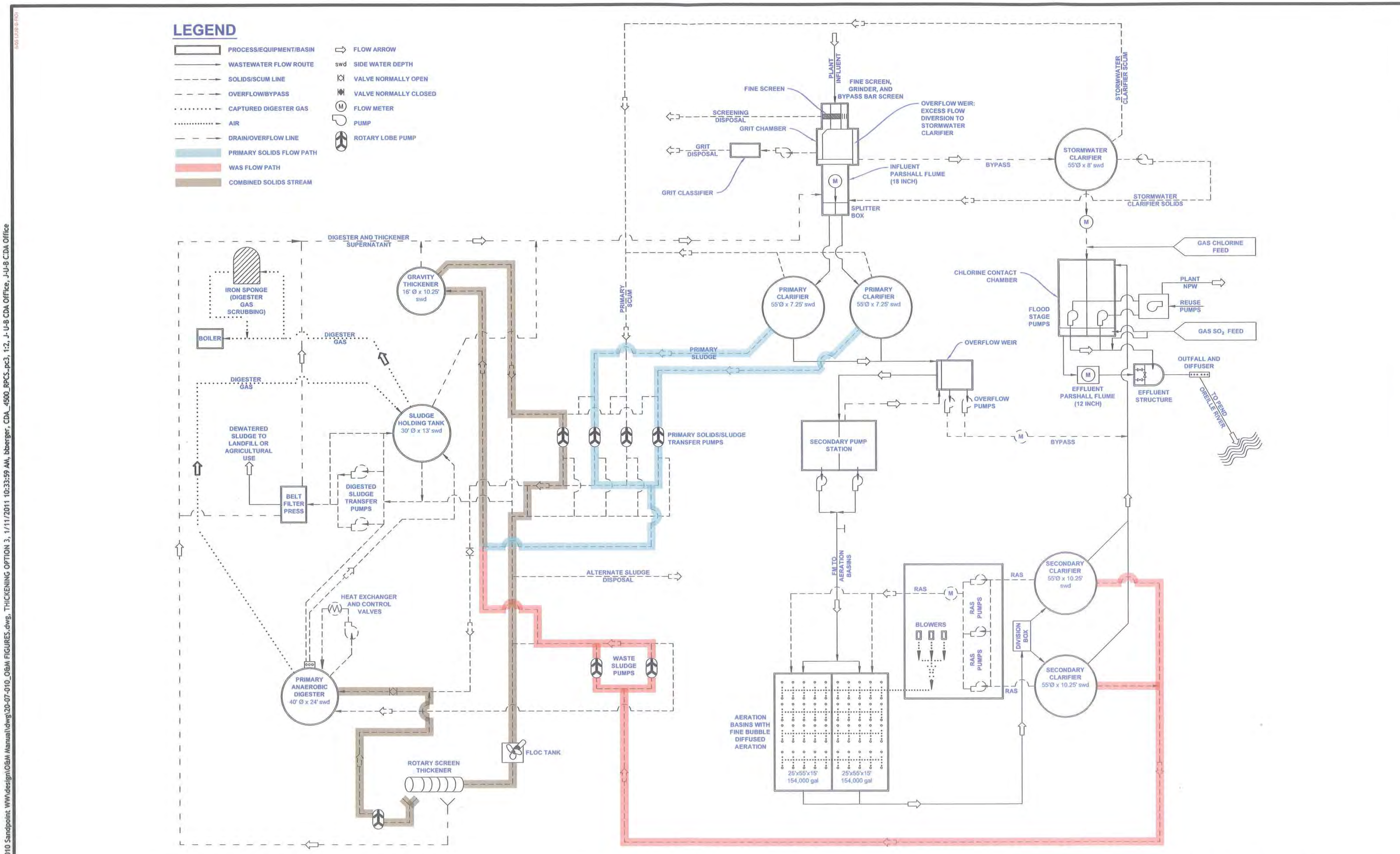
Odor generation will be more severe with this option due to primary solids in the Gravity Thickener and RST. Care should be exercised to minimize odor generation and overflowing material to the primary clarifiers, which can spread the odor problem.

11.4.4 Thickening Option 4

Thickening Option 4 appears schematically on **Figure 11-10**. This option is similar to the solids management approach prior to the addition of the RST with the 2008-2010 upgrades. This option routes settled solids from the primary clarifiers and WAS from the secondary clarifiers to the gravity thickener, and then conveys the solids to the anaerobic digester using the sludge transfer pumps.

The control logic for this option consists of the following:

- Primary solids pumps operate on a timer with the following programmable user set points to draw from the primary clarifier and feed to the gravity thickener:
    - Duty time for pumps on/off
    - VFD speed or pumping rate



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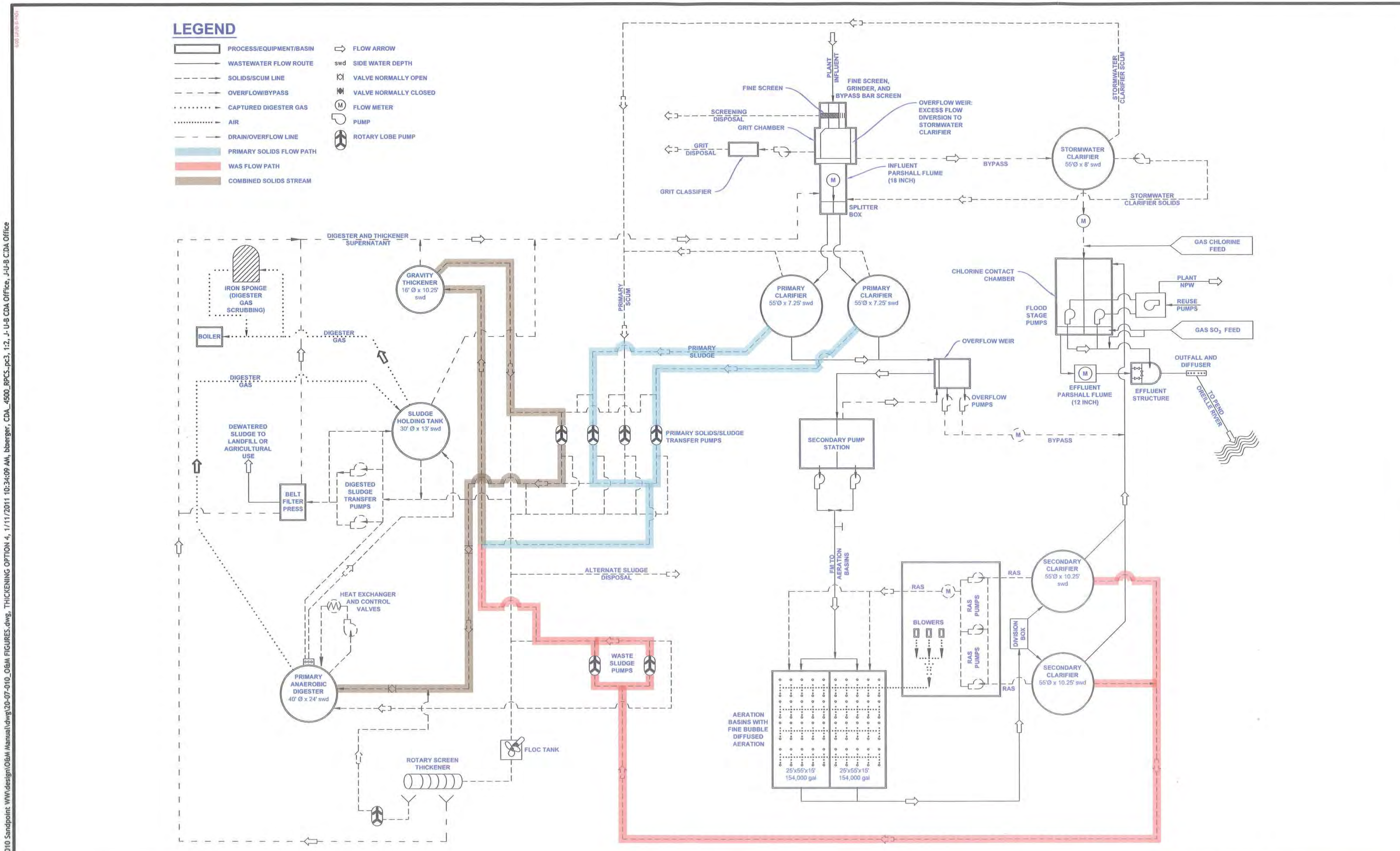
J-U-B ENGINEERS, Inc.

CAD FILE: 20-07-010_O&M FIGURES

CITY OF SANDPOINT
WASTEWATER TREATMENT PLANT O&M

THICKENING OPTION NO. 3
FIGURE 11-9



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CAD FILE: 20-07-010_O&M FIGURES

CITY OF SANDPOINT
WASTEWATER TREATMENT PLANT O&M

THICKENING OPTION NO. 4
FIGURE 11-10

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- Secondary WAS pumps operate on a timer with the following programmable user set points to draw from the secondary clarifier and feed the gravity thickener:
  - Duty time for pumps on/off
  - VFD speed or pumping rate
- Sludge transfer pumps operate on a timer with the following programmable user set points to draw from the gravity thickener and feed the anaerobic digester:
  - Duty time for pumps on/off
  - VFD speed or pumping rate

Odor generation will be more severe with this option due to exposed primary solids in the Gravity Thickener. Care should be exercised to minimize odor generation and overflowing material to the primary clarifiers, which can spread the odor problem.

11.4.5 Thickening Options 5 through 8

Thickening options 5 through 8 (reference **Table 11-3**) are additional possible thickening options and are therefore included in this O&M manual for reference. Although these options exist, they are not considered typical operating conditions. An automated program is not available for these options and manual operator control of valves, pumps, and equipment is necessary to operate in any of these modes.

Chapter 12

Biosolids Handling: Anaerobic Digestion

Chapter 12 – Biosolids Handling: Anaerobic Digestion

12.1 Abandoned Primary Digester

The old primary digester has been abandoned due to unsafe structural integrity. The old digester does not receive or discharge sludge. Because the old digester is unsafe to operate, it is not considered in this document.

12.2 Primary Anaerobic Digester

12.2.1 Component Description

The primary anaerobic digester receives thickened WAS from the secondary clarifiers, the gravity thickener, or the RST; the digester can also receive primary solids directly from the primary clarifiers. The reader's attention is directed to Chapter 11 for a discussion of the various thickening and feed mechanisms for the anaerobic digester.

The digester anaerobically metabolizes solids, reducing the volatile content of the solids and aerating methane. The primary anaerobic digester operates on a single-stage, high-rate system. There is only one digestion vessel and that vessel is "completely mixed" without an intentional zone of separation. Primary anaerobic digester information is documented in **Table 12-1**.

Table 12-1 - Primary Anaerobic Digester Summary

Item	Primary Anaerobic Digester	Recommended Range	Units
Diameter	40		feet
Side Water Depth	24		feet
Volume	225,000		gallons
Solids Residence Time	16 [a]	10-20	days
	13 [b]		
Volatile Solids Reduction	50	40-60	percent
Hydraulic Loading	14,000 [a]		gallons/day
	17,300 [b]		
Solids Loading	0.09 [b]	0.12-0.16	lb VSS/(cf-day)
	0.1 [b]		
Operating Temperature	95		°F
Construction Material	concrete wall, steel cover		-
General Condition	Digester interior was cleaned in 2008 to remove rags and debris. The lower 8 feet of the walls were sandblasted and recoated. The upper portion will need to be recoated within the next five years or less as the coating system is failing.		

[a] *Average day*

[b] *Daily load during a peak month event*

12.3 Digester Mixing Pump

12.3.1 Component Description

The primary digester sludge is mixed with a 15 hp centrifugal pump that draws sludge from the bottom center and the top center of the digester and pumps it back into the digester along the periphery in three different locations and elevations. The sludge, entering the digester at an angle, provides rotational energy for tank mixing. Pneumatic control valves vary the discharge pipe periodically to redirect the flow to enhance mixing. The mixing pump is located in the primary digester equipment room. Digester mixing pump information is documented in **Table 12-2**.

Table 12-2 - Sludge Mixing Pump Summary

Item	Mixing Pump	Recommended Range	Units
Type	Hayward Gordon		
Size	15		hp
Rated Capacity	1,500		gpm
Rated Head	20		feet
Rated rpm	1,150		rpm
Mixing Energy	0.5	0.2-0.3	hp/1,000 cf

During the 2008-2010 upgrades, the pump mixing system was upgraded as follows:

- New manual bulkhead isolation valves on sludge mixing lines
- New automated mixing valves
- Option to use either the upper or lower sludge suction line for introduction of heated sludge into the mixing lines

12.4 Digester Heating

12.4.1 Component Description

The digester is heated by heating the digester sludge with an Alfa Laval spiral heat exchanger. A sludge recirculation pump pulls sludge from the digester and pumps it through the heat exchanger. Heated sludge is forced from the heat exchanger to the sludge mixing pump suction line, where it is circulated back into the digester. Hot water is heated by one of two boilers in the Boiler Building east of the Control Building and pumped through the heat exchanger.

To heat the incoming sludge and make up for the loss of heat through the digester's concrete walls and a steel cover, the digester can require up to 345,000 BTU per hour to maintain optimal warmth during cold winter conditions. The heating system is not set up to handle steam; therefore, the maximum allowable temperature differential across the heat exchanger is less than 212° F. Typically, the boilers produce only 140° F water. The heat exchanger is located in the Primary Digester Building and was upgraded on the 2008-2010 upgrades. Information regarding the new heat exchanger is documented in **Table 12-3**.

Table 12-3 - Heat Exchanger Summary

Item	Heat Exchanger	Units
Type	Alfa Laval	
Size	70	square feet
Circulation Pump	2 hp Paco	
Approximate Capacity	2,340	BTU/(hr-°F)
Approximate Rate	455,500	BTU/hr (@ ΔT=114° F)

The boilers are located in the Boiler Building next to the Primary Sludge Pump Building. Boiler information is documented in **Table 12-4**.

Table 12-4 - Boiler Summary

Item	Boiler 1	Boiler 2	Units
Type	Bryan	American Standard	
Size	360,000	216,000	BTU/hr

12.5 Boiler Capacity

The boilers have a combined output of 576,000 BTU per hour, which can provide the heat exchanger with approximately 460,000 BTU per hour, assuming a 20 percent loss between the boiler room piping and the hot water piping to the digester. This 460,000 BTU per hour is sufficient to heat the digester, assuming standard heat loss coefficients for concrete and steel.

12.6 Digester Gas Reuse

Anaerobic digesters naturally produce methane that can be used to offset the natural gas demand of the boiler. A gas purification system was installed as part of the 2008-2010 upgrades and is discussed in more detail in Chapter 15.

Chapter 13

Biosolids Handling: Dewatering and Disposal

Chapter 13 – Biosolids Handling: Dewatering and Disposal

13.1 Biosolids Dewatering and Disposal

Immediately following anaerobic digestion, digested sludge flows by gravity from the anaerobic digester to the sludge holding tank where it is pumped to one or two belt filter presses. These systems were not modified during the 2008-2010 improvements. A summary of these components follows; attention is directed to the 1982/1983 drawings and O&M Information related to these components.

13.2 Digested Sludge Holding Tank

13.2.1 Component Description

The sludge holding tank receives digested sludge from the primary digester, storing the sludge until it is dewatered and hauled offsite for disposal. Typically, the WWTP dewaters sludge three days a week, for a total dewatering time of approximately 24 hours per week. Digested sludge flows by gravity to the anaerobic sludge transfer pumps, where it is pumped to the dewatering facilities. The holding tank has a floating cover. The tank head space is used to store digester gas. The burner and the boiler draw gas from the head space.

Digested sludge holding tank information is documented in **Table 13-1**.

Table 13-1 - Sludge Holding Tank Summary

Item	Sludge Holding Tank	Units
Diameter	30	feet
Construction Material	concrete	
Volume	77,800	gallons
Cover	floating	
General Condition	Unknown; inspection required	

13.2.2 Capacity

The plant dewaters an average of 5,500 gallons of digested sludge per day, which provides an average hydraulic residence time in the holding tank of 14 days. Because the plant typically dewaters sludge every 3 to 4 days, the holding tank has sufficient capacity to buffer dewatering activity. However, the holding tank often overflows digested sludge back to the headworks, which can be a source of odors at the facility.

13.3 Digested Sludge Transfer Pumps

The digested sludge transfer pump station pumps sludge from the holding tank to the dewatering facilities. Digested sludge transfer pump information is documented in **Table 13-2**. Each pump has a dedicated 2 hp JWC grinder on the suction piping, and the pumps have recently been overhauled. Their overall condition is good, and the system has adequate capacity for current flows and loads.

Table 13-2 - Primary Sludge Pump Station

Item	Pump 1	Pump 2	Units
Year Installed	1983	1983	
Maker	Moyno	Moyno	
Hp	5	5	
Rated Capacity	40	40	gpm
Rated Head	35	35	Feet
Type	Screw	Screw	
	Progressive Cavity	Progressive Cavity	
Flow Metered	Totalizer	Totalizer	
VFD	Yes	Yes	

13.4 Biosolids Dewatering

13.4.1 Component Description

Biosolids dewatering is accomplished by one of two 1-m belt filter presses. Digested solids are pumped from the holding tank to the dewatering facilities via the digested solids transfer pumps. The dewatered cake is discharged from the belt filter press directly into a truck for offsite disposal. The filtrate water flows by gravity back to the headworks. Dewatering facilities information is documented in **Table 13-3**.

Table 13-3 - Sludge Dewatering Facilities Summary

Item	Current	Typical	Units
Number of Presses	2.0		
Size	1.0		meter
Loading	1,800	9,600	lb/day
Sludge Concentration Feed	2.2		percent
Polymer Dose	5-18		lb/ton
Solids Capture	90		percent

13.4.2 Capacity

The dewatering facilities currently process an average of 341 pounds of biosolids per day. Because the facilities are able to handle 1,800 pounds per day, the operations are under 20 percent of full capacity. The BFP units capacity appears to be adequate for existing sludge production, with some capacity for growth and redundancy of units for operation.

Chapter 14

Plant Water Systems

Chapter 14 – Plant Water Systems

14.1 General

As part of the 2008-2010 upgrades, several improvements were made to the plant water systems, as part of an on-going effort to remove and eliminate potential cross-connections within the WWTP. The Sandpoint WWTP currently uses potable water for drinking water and emergency eyewash/shower station purposes and reused disinfected effluent for process applications, and wash-down water.

14.2 Potable Water Systems

14.2.1 General

The potable water system PW1 and PW2 was added during the 2008-2010 upgrades to begin the process of eliminating potential cross-connections within the plant. As part of the 2008-2010 upgrades, a 6-inch main line was routed through the plant as well as individual 1.5-inch lines servicing each of the plant buildings requiring potable water. Subsequent projects during 2009 and 2010 will finish internal plumbing to potable fixtures in each of these buildings whereby disconnecting all potable fixtures from the old plant water system.

One 6-inch waterline serves The WWTP potable system (PW1 and PW2). Refer to the C01 Sheets of the Record Drawings for the approximate location. The waterline enters the northwest corner of the plant then passes through primary reduced pressure backflow assembly (RPBA) within a heated enclosure. This line provides service to all of the plant potable uses, and is the potable back-up supply (following an air-gap) for the Non-Potable reuse system.

The potable water system will eventually serve (following all plumbing upgrades) the lavatory, the emergency eyewash and showers, shower, wash sinks, boiler feeds and drinking fountains.

14.2.2 Maintenance

A watertight heated enclosure protects the RPBA backflow preventer from outside conditions. To satisfy plumbing code requirements, service and test the RPBA for proper operation on an annual basis (e.g., every June).

> *WARNING: Potable and non-potable water sources must never be interconnected. Doing so would present an unacceptable risk to public health in the treatment plant and City water systems.*

14.3 Non-Potable Water Reuse System

14.3.1 General

The Sandpoint WWTP constructed a separate non-potable water reuse system as part of the 2008-2010 improvements for use throughout the plant for non-potable needs. Treated effluent from the Chlorine Contact Chamber flows into a sump where vertical turbine pumps discharge through an automatic backwashing filter into the plant reuse water system. The NPW1 system constructed in the 2009 upgrades will provide filtered water to various processes throughout the WWTP including the dechlorination injection system, headworks spray and washdown water, rotary screen thickener spray and washdown water, and WWTP landscape irrigation.

> ***WARNING:*** *Potable and non-potable water sources must never be interconnected. Doing so would present an unacceptable risk to public health in the local and City water systems.*

Subsequent projects following the 2008-2010 upgrades are scheduled by the City to create a dedicated new potable water system throughout the WWTP. Following the completion of that work, the remaining existing plant water system can be connected to the NPW1 reuse system. The new NPW1 system will provide reuse water for the remaining non-potable uses including clarifier and aeration basin spray water, pump seal water (with increased filtration), and yard hydrant washdown water.

Photos of the non-potable reuse pumping system appear on Figure **14-1** and **Figure 14-2**, and the pump design criteria are listed in **Table 14-1**.

The vertical turbine reuse water pumps are supplied by PumpTech Inc. and manufactured by Peerless Pumps. The operator should refer to the manufacturer's O&M Manual provided by the contractor prepared for the 2008-2010 upgrades for detailed operation and maintenance procedures. Contacts for the pumps are:

Peerless Pump Company (manufacturer)
P.O. Box 7026
2005 Dr. Martin Luther King Jr. Street
Indianapolis, IN 46207-7026
Phone: 317-925-9661
Fax: 317-924-7388

Pump Tech, Inc. (representative)
Ed Smith
9 Pelican Place NE
Moses Lake, WA 98837
Phone: 509-766-1547
Fax: 509-765-3926

14.3.2 System Components

The system is comprised of:

- Two vertical turbine pumps and motors (10 HP and 25 HP) with space for a second 25 hp pump and motor
- Discharge piping and valves
- Pressure relief
- Air release piping
- Magnetic flow meter
- Automatic Backwashing Filter (discussed subsequently)
- Hydropneumatic Tank (in the Dechlorination Building)
- Electrical controls

Figure 14-1 – Non-Potable Water System Vertical Turbine Pumps

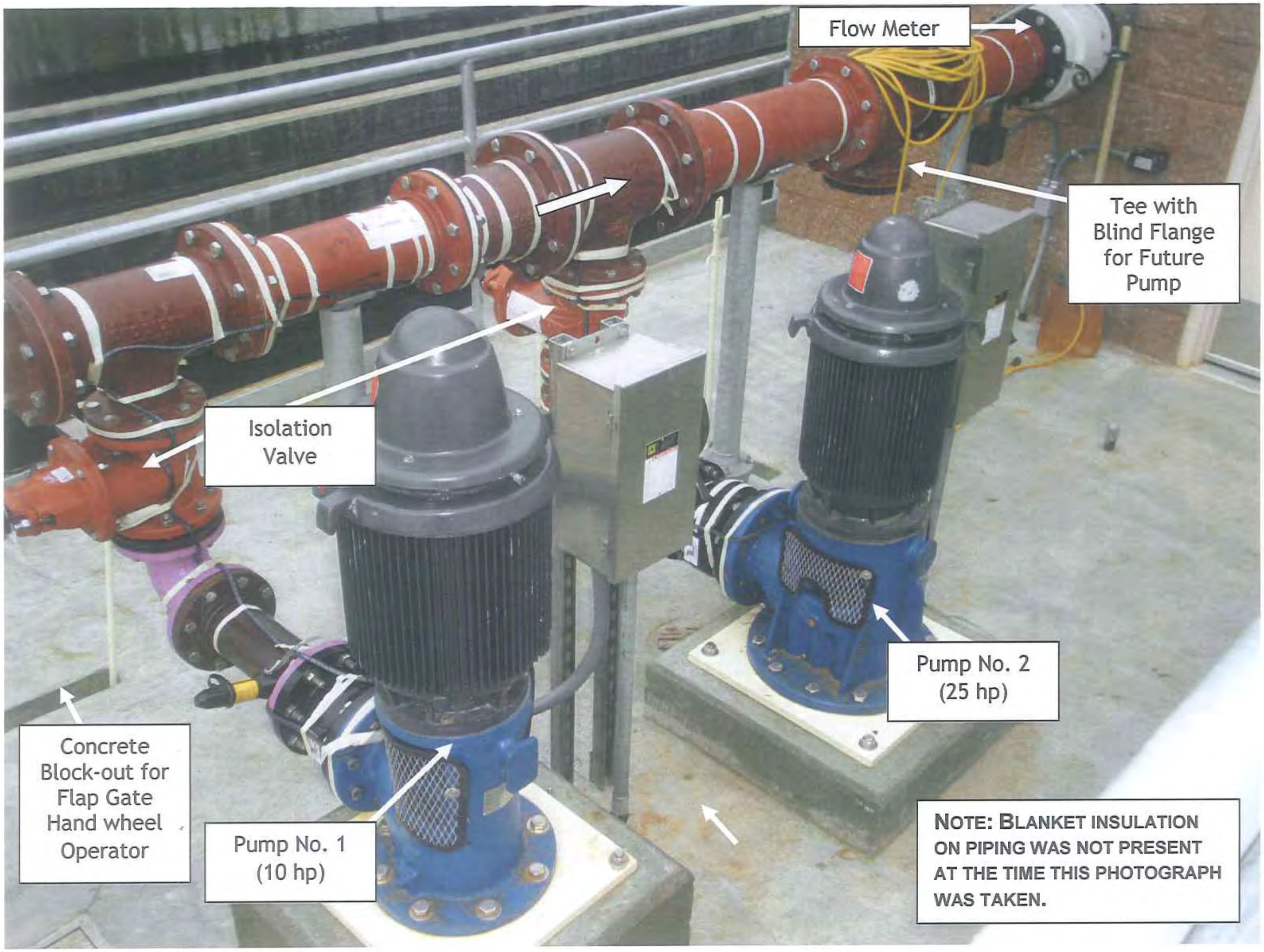


Figure 14-2 – Non-Potable Water System Automatic Filter and Discharge Piping

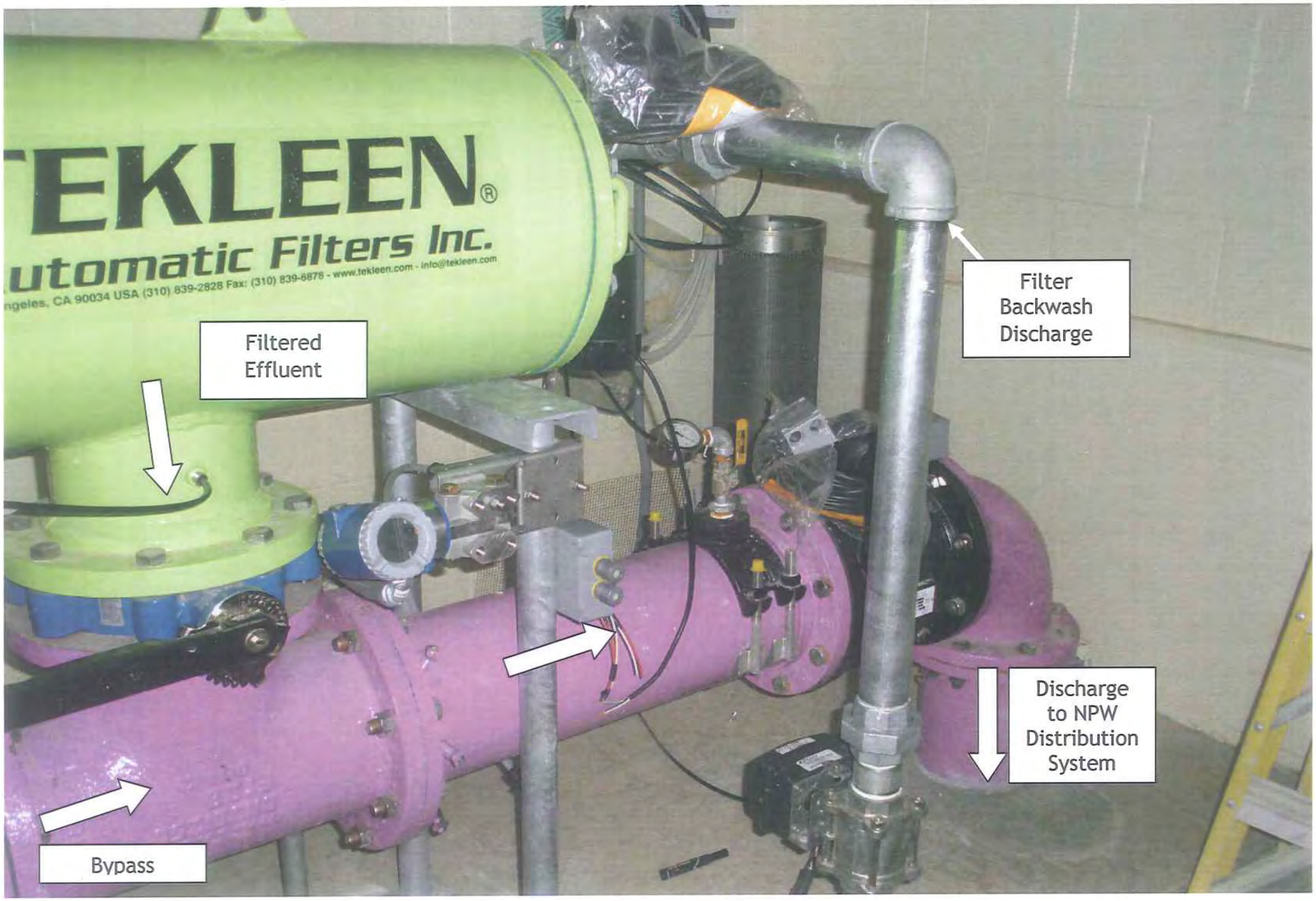


Table 14-1 - Pump Information

Pump Number	Hp	Capacity (gpm)	Model	RPM	Length of Pump (below pump pad) (inches)	TDH (feet)
1	10	150	6MA - 14 stage	1,770	136	190
2	25	350	8HXB – 8 stage	1,770	130	190
3 (future)	25					

See manufacturer's O&M Manual for pump curve information.

14.4 Reuse Pumping System Operations

Operation of the reuse pumps begins when a signal from the system pressure gage indicates a low distribution system pressure. If the pressure reaches pre-set pressure (typically 50 psi), the first pump turns on; if the pressure continues to drop to second pre-set level (typically 45 psi), pump 1 shuts down and the second, larger pump turns on. A third, low-low pressure setting (40 psi), results in restarting the first pump to maintain pressure in the system.

No changes to the programmable set points should occur without the approval of the lead WWTP operator. The City's programmer should assist when the changes to the programming appear necessary. Spare copies of the PLC programming should be quickly available in the event the existing programming fails or becomes corrupted.

Pressure Relief: The pressure relief valve is set to discharge if the pressure in the system rises above 100 psi. This serves to protect the discharge piping from high pressure if the pipe is obstructed either by a closed valve or in the event of a power failure.

Potable Water Supply: In the event the Chlorine Contact Chamber effluent is of poor quality or has to be taken off line for cleaning, the NPW basin can be isolated and the basin can be used as a wet well with a potable water air-gap. Potable water is added to the basin by a float control valve (located on the southeast corner of the automatic filter room). The float control valve operates on two level floats, allowing the basin level to fluctuate and maintain adequate water level for pumping.

Operation and adjustment of the float control valve (for potable water supplement) and pressure relief valves require specific information covered in a separate O&M Manual, provided by in the Contractor's O&M information.

Table 14-2 - Pumping System—Common Operating Problems

Problem	Cause	Solution
Pumps run but have no flow	1. Incorrect valve settings/closed valves.	1. Verify that all control valves are open.
	2. Pump intake screens are clogged.	2. Verify screens are free of debris.
Pump malfunction/fails to start	If the pump is drawing too many amps, the overload circuits will trip, turning the pump off.	
	1. This may be due to material clogging the impellers, which will cause additional friction in the impeller and draw more amperage.	1. Check discharge lines for obstructions and clean if necessary. Troubleshooting for those items is discussed in the manufacturer's O&M Manual.
	2. Other problems may be in the motor or the drive.	2. Check the motor and drives to ensure adequate operation.
	3. Other problems may be with regard to the automatic filter, (i.e., plugging and creating excessive backpressure)	3. Check the filter is allowing flow through it. Check that the flow meters shows that flow is moving through the system and that the pressure relief valve isn't open.
Pump fails to call	1. If the pump fails to start when called, it may have been locked out at the MCC. If so, the pump will not be available to the PLC to run.	1. To identify the problem, the operator should verify the status of the pumps at the MCC, drive panels, and PLC. The valve positions also should be checked to make sure the pump can deliver water when required.
	2. The pump also may be turned off by the operators for maintenance or to control pump operations during low demands.	2. Verify that the pump will start on "HAND."
	3. The pumps also will not operate if the valves are closed or the check valves are not operating properly.	3. Operate the "HAND-OFF-AUTO" switches at the main panel. If the pump works in the "HAND" position, the problem is in the PLC.
	4. Telemetry may not be operating properly.	4. If the motor does not start in the "HAND" position, reset the overload relays. If the pump does not start after resetting, the problem lies in the control panel and an electrician should be called in to isolate and repair the defect.

Problem	Cause	Solution
Low pumping rate	1. A valve may be partially closed.	1. Verify that all valves are in correct positions, and then try ramping the pump up to see if flow increases.
	2. Welds in pump column may be leaking.	2. This may be caused by excess shear force on the pump column or general deterioration. Operators need to monitor discharge flows on a regular basis to identify any leakage.
	3. Clogging of pump intake screens.	3. Verify screens are free of debris.
	4. Air-locking of pumps or piping.	4. Verify all air is bled out of discharge piping and autofilter.

Periodically, the operator should compare flow and discharge pressure for each pump against the theoretical flows shown in the pump curves. Discharge pressure and flows also should be monitored over time to identify any long-term trends in system operation. These items together can identify problems that gradually but ultimately may reduce the capacity of the system.

Tabl3 14-3 - Common Discharge Piping Operating Problems

Problem	Cause	Solution
Leaking pipe	A leaking pipe may be caused by loose bolts or by general deterioration of the pipe and or gaskets.	In order to control or prevent this, the operators need to check to see if the bolts are tight and monitor any discharges from the main line through gaskets or flange faces for general deterioration. The operators need to check for discoloration, brittleness in the rubber gaskets, or other signs of deterioration.
Pressure relief valve does not work	The valve or valve pilots may be clogged.	Isolate the discharge piping by closing the isolation valve.

14.5 System Maintenance

Operated and maintain the pumps and motors in accordance with the pump O&M information (bound separately). Additionally, perform the following maintenance protocol:

- Keep the pump station clean at all times to prevent dirt, dust, scum, and debris from accumulating.
- Manually operate all valves regularly.
- Check pressure gauge and flow meter accuracy annually, and calibrate or replace as needed.

- Twice a year, clean electrical panels and junction boxes per the manufacturer's recommendations.
- Re-paint all piping annually or bi-annually, as required to prevent corrosion.
- Inspect heat trace and insulation annually or bi-annually, as required to prevent freezing of pumps and piping.

14.5.1 Automatic Self Cleaning Filter

The non-potable water reuse system at the WWTP is equipped with a 500 micron automatic backwashing filter to remove material from the chlorinated effluent prior to distribution for plant utility water. A 300 micron element was also supplied, but initial operation indicates that the 500 micron element is providing adequate protection from clogging of spray nozzles in the plant.

Normally the automatic filter will be self cleaning. In the event of a plant upset, the filter element could become fouled with excessive material/debris, and the filter element may need to be removed and cleaned. Additionally, the first year of operation indicates that algae buildup on the downstream side of the filter element will also become a problem every two to four months. The screen element should be removed and the exterior cleaned every two to four months to remove any buildup and prevent material from migrating into downstream piping.

The automatic self cleaning filter was manufactured by Tekleen, Inc. The operator should refer to the manufacturer's O&M Manual provided by the contractor prepared for the 2008-2010 Sandpoint Wastewater Treatment Plant Upgrades for detailed operation and maintenance procedures. Contact information for the filter is:

Tekleen Automatic Filters, Inc. (Manufacturer)
2672 S. LA Cienega Blvd.
Las Angeles, CA 90034
Phone: 310-839-2828
Phone: 800-336-1942
Fax: 310-839-6878
Email: info@tekleen.com
Web:WWW.tekleen.com

Normal Operating Conditions: Under normal operating conditions, the automatic filter will operate in forward flow mode. Under this operating condition, flow will pass through the filter (inside out) of the filter element. As captured debris plug the filter, it will reach a differential pressure of 7psi across the filter element, and will automatically initiate a cleaning cycle. Additionally, the cleaning cycle can also be set on timer operation to clean at pre-set intervals.

During a cleaning cycle, the filter will automatically start the rotating scrub-brush assembly, and exhaust the accumulated material to waste. The waste stream has lines routed to the head end of the Chlorine Contact Chamber, or back to the stormwater clarifier. The operator must manually adjust the valves on the waste drain lines to alter the discharge point for the backwash wastewater.

Alternate Operating Conditions: In the event the filter must be taken off-line for an extended period, for maintenance, a bypass line with associated valves has been installed around the filter.

For filter bypass operation, close the valves on the lines from the Chlorine Contact Chamber, and the system will operate on water discharged from the potable water air-gap. This air-gap water is of much higher quality and will minimize the amount of material that is being pumped into the NPW1 distribution system while the filter is being bypassed.

14.5.2 Hydropneumatic Tank Operation

A 500 gallon hydropneumatic pressure tank is installed in the Dechlorination Control Room. This tank provides equalization for system pressures within the NPW1 system during low flow period. Drain the tank and inspect it annually for damage and wear on the tank bladder.

Chapter 15

Digester Gas Purification System

Chapter 15 – Digester Gas Purification System

15.1 General

A gas purifier was installed to remove corrosive and odorous hydrogen sulfide H_2S from the anaerobic digester gas. The purifier functions by passing sewage gasses from the anaerobic digester through iron oxide impregnated wood shavings (iron sponge). The H_2S is removed from the digester gas upon a reaction with the iron oxide forming ferric sulfide. Periodic exposure of the iron to atmospheric oxygen will return the ferric sulfide to iron oxide, recharging the purifier and producing pure sulfur.

The gas purifier is supplied by Victor Pedroni and manufactured by Marcab Company, Inc. The operator should refer to the manufacturer's O&M Manual provided by the contractor prepared for the 2008-2010 Sandpoint Wastewater Treatment Plant Upgrades for detailed operation and maintenance procedures. Photographs of the Gas Purifier System are included for visual reference on **Figures 15-1** and **Figure 15-2**.

Contacts for the purifier are:

Marcab Company Inc. (manufacturer)
155 Balboa St.
Suite D-9
San Marcos, CA 92069
Phone: 760-510-8030
Fax: 760-510-8031

Pedroni & Co. (representative)
Victor Pedroni
4580 Klahanie Dr. SE #271
Issaquah, WA 98027
Phone: 425-369-6164
Fax: 425-963-8600
Email: victor@pedroni-co.com

15.2 System Components

The system is comprised of:

- Fiberglass gas purifier tank filled with iron sponge media
- Piping to and from the gas purifier to the Primary Pump Room
- Drip trap (in the Primary Pump Room)

Table 15-1 presents general information about the purifier.

Table 15-1 - Purifier Information

Size (OD)	Volume (ft^3)	Tank Weight (lbs)	Iron Sponge Weight (lbs)	Low Temp (°F / °C)	High Temp (°F / °C)
8'	294	7,000	15,000	35 / 2	120 / 49

Figure 15-1 – Gas Purifier

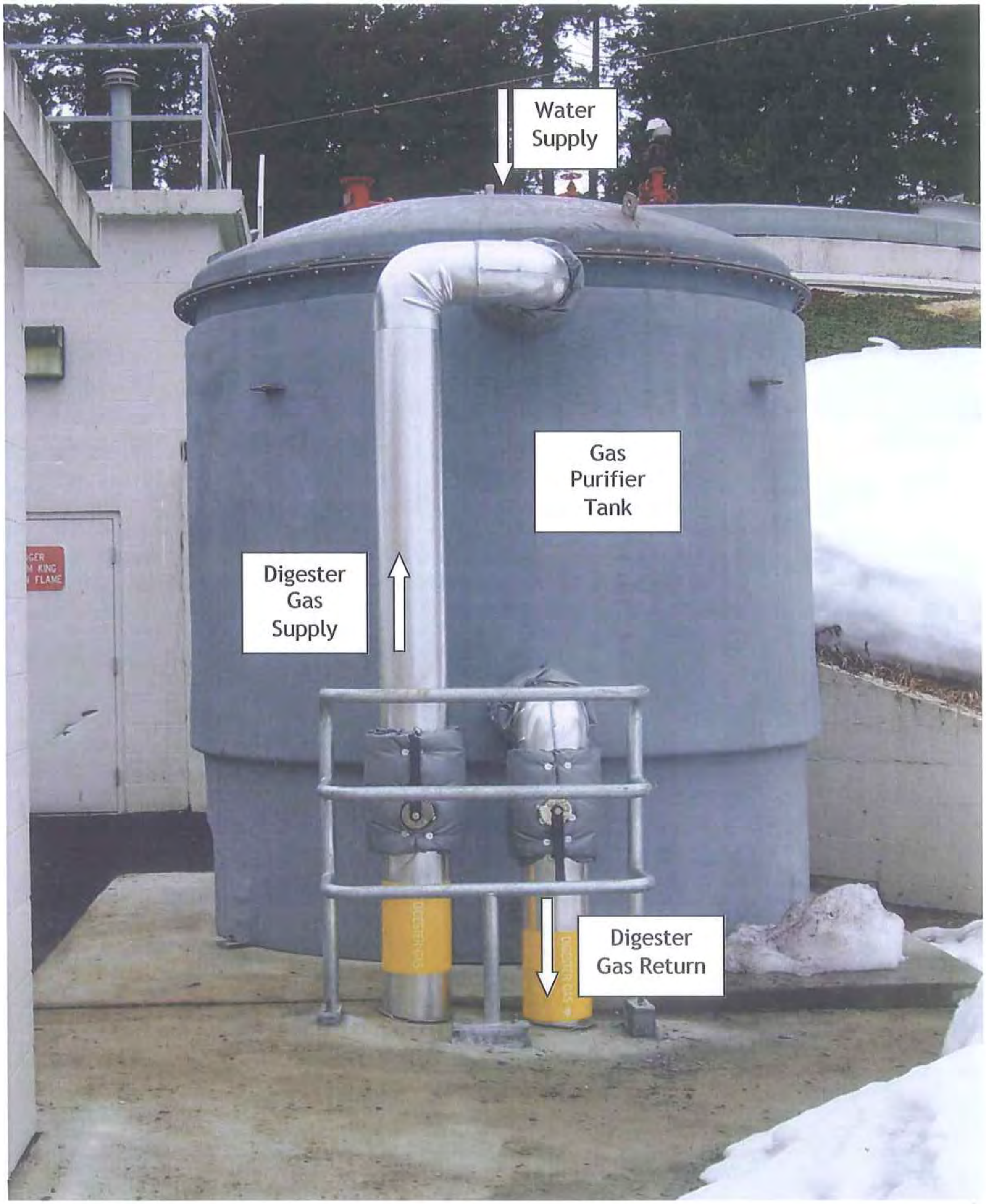
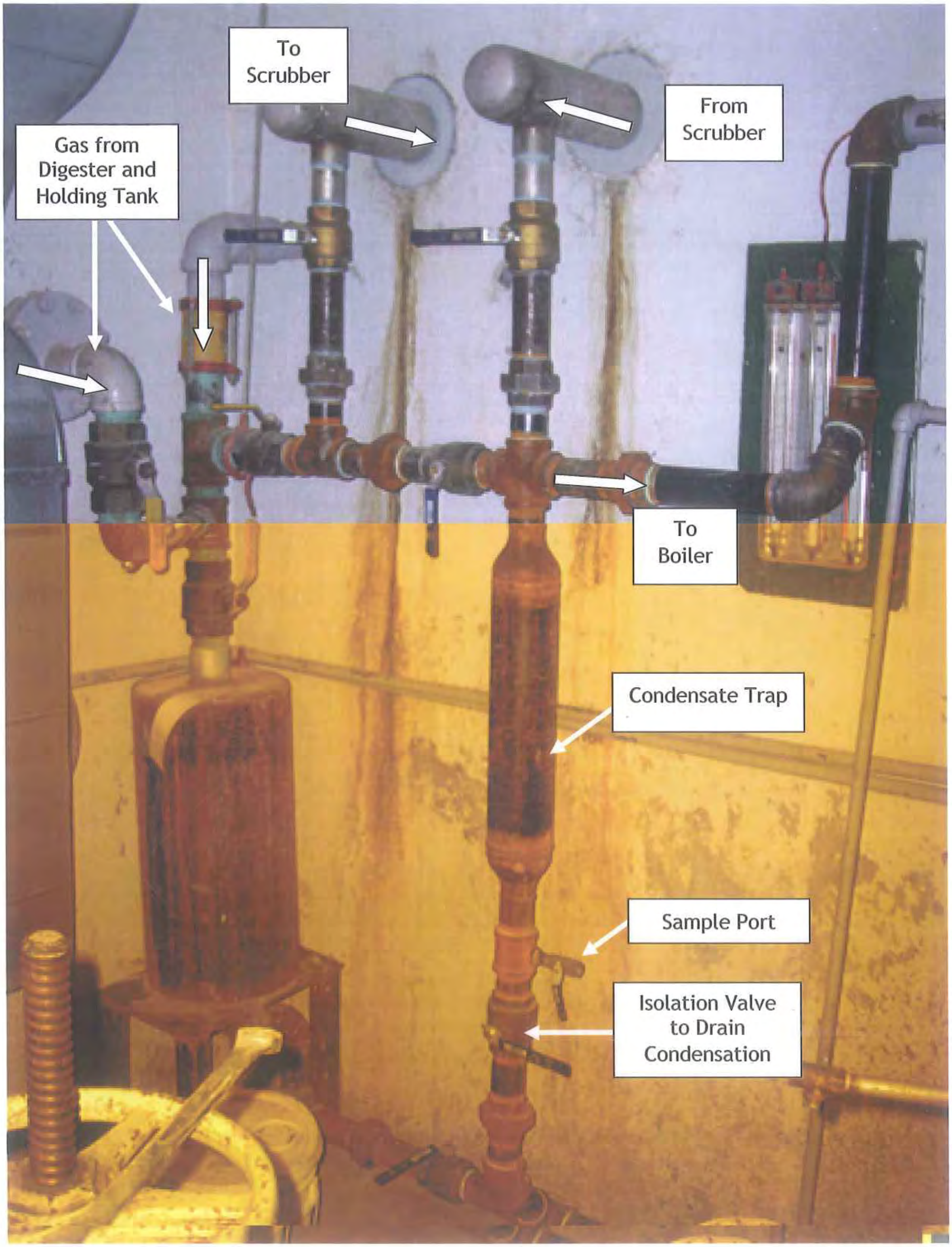


Figure 15-2 – Condensate Collection System (in Primary/Transfer Pump Room)



15.3 Regular Operations and Monitoring of the Purifier

The purifier reacts with iron oxide with H_2S to form ferric sulfide. The system will also remove mercaptans, some volatile and semi-volatile hydrocarbon odors and amine odors.

Temperature: Monitor bed temperature regularly. Bed temperature should remain below 120° F (49° C).

Gas Samples: Regularly collect samples from both inlet and outlet of purifier to be measured for H_2S content and recorded for performance analysis. The maximum rated concentration of the purifier is 300 ppm H_2S. Outlet concentrations above 4.5 ppm H_2S indicate spent iron sponge.

Drip Tap: Open the drip tap daily to drain condensate from the purifier. Approximately 1 to 4 pints of water should drain from the drip trap daily.

Continually monitor condensate to ensure a pH of 7.0 or above is maintained. Should the pH drop, the addition of sodium carbonate or sodium bicarbonate may be required. Consult manufacturer's O&M literature if pH adjustment is required.

15.4 Gas Purifier System—Common Operating Problems and Troubleshooting

Problem	Cause	Solution
No Drip Water	1. Sponge is drying out	1. Add additional water to Purifier
	2. Inlet port of Drip Tap blocked	2. Disassemble and clean Drip Tap
Gas Odor	1. Gas Leakage from Purifier	1. Check gaskets, flange bolts tight, flange mated properly;
Outlet H_2S concentration is too high	1. Sponge is saturated	1. Regenerate or replace sponge
	2. pH of Sponge is too low (i.e. < 8.0)	2. Add sodium carbonate or sodium bicarbonate as described in manufacturer's literature.
	3. Moisture is too low, sponge will cease to function below 10-15% moisture (W/W)	3. Add water to sponge through tap spray nozzle.
	4. Gas is short circuiting around sponge or sponge media has been consumed	4. Remove and Re-install sponge ensuring perimeter is packed with feet while raking. Consult manufacturer's literature on expected life span of media.
Low flow rate	1. A valve may be partially closed.	1. Verify that all valves are in correct positions.
	2. Sponge is compacted	2. Re-install sponge ensuring the center is loosely placed

15.5 System Maintenance

15.5.1 General

The following general maintenance protocol should be performed:

- Manually operate all valves regularly.
- Re-paint all piping annually or bi-annually, as required to prevent corrosion.
- Inspect insulation annually or bi-annually, as required to prevent freezing of piping.

15.5.2 Removing Purifier Cover and Media Replacement

Consult manufacturers recommended sequenced and procedures for removing the purifier lid for maintenance. Exposure of the spent media to oxygen will cause the media to begin to regenerate. This is an exothermic reaction, which generates considerable heat.

15.5.3 Regeneration of Iron Sponge

Sponge regeneration may occur by removal and spreading on concrete, allowing atmospheric oxygen to regenerate iron oxide compounds or through filling the purifier with water and bubbling air through it. Consult the manufacturer's O&M manual for specific details and recommended process.

15.5.4 Disposal of Iron Sponge

> ***WARNING: The manufacturer recommends the use of NIOSH approved dust masks, non-absorbent safety gloves, and OSHA approved glasses or goggles whenever handling Iron Sponge material.***

Iron sponge is generally non-toxic and can be disposed of by burying or at a local landfill. Consult local environmental agency for preferred disposal method.

To avoid fire hazard, initially spread sponge in approximately 6-inch layer on soil to allow full oxidation of any un-reacted material.

Consult State Transportation Department for safety and handling requirements before transporting iron sponge.

15.5.5 Installation of Iron Sponge

Ensure purifier base grate is clean and in good repair.

> ***WARNING: The manufacturer recommends the use of NIOSH approved dust masks, non-absorbent safety gloves, and OSHA approved glasses or goggles whenever handling Iron Sponge material.***

Ensure moisture content is between 35 and 45 percent with either a laboratory test or hand approximation. For "Hand" approximation, take a gloved handful of Iron Sponge and squeeze tightly. If water runs freely through fingers, the iron sponge is too wet. If no water runs out and iron sponge can be blown away or separates into individual pieces, iron sponge is too dry. If iron sponge clumps and no water can be squeezed out, moisture is approximately correct.

> ***Note: If the iron sponge is too wet, it can cause reduced sponge "life" or increased pressure drop.***

Check pH and ensure it is between 7 and 8 (use lab test or pH paper).

Position iron sponge bags 2-feet above bottom of purifier and cut bottom allowing iron sponge to fall loosely into purifier. Pack outside of iron sponge material and avoid stepping on the center of the iron sponge. Use a rake to level iron sponge after each bag is loaded. If center is stepped in, use rake to loosen that area. Pack the entire perimeter for each layer to avoid short circuiting of gasses along purifier walls. Fill purifier to within 1 foot of inlet pipe.

Ensure lid gasket is in place and bolt cover in place, squeezing O-ring to no less than ½ uncompressed height.

Leave valves closed until gas is flowing to prevent iron sponge from drying out.

Chapter 16

Electrical, Instrumentation, and Control

Chapter 16 – Electrical, Instrumentation, and Control

16.1 General

This section describes the operation of the electrical service, instrumentation, PLC, and SCADA control system at the Sandpoint Wastewater Treatment Plant (WWTP). The system consists of the following major components:

- Automatic Transfer Switches and Generators
- Motor Control Centers
- Control and Instrumentation Systems (SCADA)
- Alarm Systems (SCADA and Autodialer)

This operation manual is intended to provide an overview of the main system components, and general operational procedures for the SCADA system. Detailed maintenance and repair and additional operational procedures are included in the equipment Operation and Maintenance manuals.

16.2 Electrical Service, Automatic Transfer Switches and Generators

The existing treatment facility is fed by Avista Utilities under rate schedule 021, Large General Service, account number 2127888. The utility transformer is a 300KVA, 12.47KV-480/277Y pad mount transformer installed as part of the 1983 plant improvement project. The existing electrical service is located in the Digester Equipment Building (panel MDP). Panel MDP is a Square D, Power Style Switchboard and is rated at 1600A, 480V, 42KAIC. The main circuit breaker is a 1600A LIG.

The main normal distribution switchboard MDP distributes three phase 480 volt power to transformer T-1, MCC-7 and the plants 600A, 3 pole automatic transfer switch that feeds the main stand-by distribution panelboard EMDP and MCC 6E. The main distribution switchboard MDP is adequately sized for the current load.

Panelboard EMDP and MCC 6E are alternately fed through the ATS by a 330KW, 480/277V, 3 phase, 4 wire, diesel fueled stand-by generator. The 330KW stand-by generator is adequately sized to run the load connected to panel EMDP and MCC 6E.

Transformer T-1 steps the voltage down to 240 volt three phase, 4 wire and then feeds panel 2MDP. Power is distributed from panel 2MDP to the original (prior to 1983) plant loads MCC-2, MCC-3, MCC-4, and MCC-5 via overhead feeders.

A 76KW, 240/120V, 3 phase, 4 wire, natural gas fueled stand-by generator provides backup power to the automatic transfer switch located in the secondary control building. The loads connected to this system include the Operations Building /secondary pump station, and part of the primary pump station.

16.3 Control and Instrumentation Systems

The aeration system, RAS/WAS system, solids thickening, de-chlorination, and grit removal systems are controlled in the automatic mode by a PLC-based control system. The monitoring and control inputs are displayed and accessed via several touch screens located on the doors of the MCC/Control Panels and by a central SCADA computer located in the Operations Building. All plant equipment has the ability to run in a manual mode in the event of a PLC control system failure.

16.4 SCADA Computer

The City's programmer is developing an overall plant SCADA system with central computer HMI in the operator's lab building.

PENDING COMPLETION

16.5 Local Control Panel Touchscreens

The touchscreen control system is organized into "screens" for each of the various pieces of equipment. The main "Main Screen" screen allows for navigation into each of the various "Data" screens for each portion of the WWTP with subsequent control screens for each area of the WWTP.

16.5.1 Security

There are three levels of security within the control system:

- Level 1: View only. When there is no operator logged in. All of the screens may be navigated and viewed. Equipment control or set point changes are not allowed at this access level.
- Level 2: Operator level access. Equipment may be automatically started and stopped from the computer. Set point modifications are allowed. The security code for this level is the final four digits of the WWTP phone number - 3433.
- Level 3: Programmer/administrator level access. Full control, including access to programming and logical controls.

16.5.2 References

The reader is referred to the contractor-provided electrical systems Operation and Maintenance manuals for service procedure for all electrical and control equipment.

16.6 Alarm Systems

In the event of a plant or major equipment failure, an alarm automatic dialer is programmed to call the "On-Call" Operator. The alarm dialer will continue to call additional numbers until the alarm is acknowledged by phone.

16.7 Safety Information

This manual describes the operation of equipment and processes critical to the operation of the WWTP. Any person working on or around the equipment described in this section must be aware that their actions may directly affect the operation of the system. SCADA computer screens assist in monitoring and control of the various systems, and the alarming system will notify operations personnel of possible equipment problems or failures. Alarms typically indicate equipment or system failures and should be referred to qualified technicians for investigation of cause and any necessary repair.

Chapter 17

Maintenance Management

Chapter 17 – Maintenance Management

17.1 General

Preventive maintenance and implementation of best management practices for the wastewater treatment facilities is a very important responsibility. Regular maintenance greatly reduces the necessity of expensive repairs and replacement of system components and equipment, and reduces problems associated with operation when a part of the system cannot be used. Therefore, good preventative maintenance contributes directly to the economical and operational efficiency of the treatment facility.

Most equipment at the WWTP requires periodic inspection, lubrication, and adjustment. As such, O&M personnel must establish a schedule for preventative maintenance and maintain good records to ensure that the maintenance is accomplished when required. A maintenance plan supported by management and carried out by O&M personnel will lead to a safe, well-operated, and reliable facility. Unscheduled or crisis maintenance is usually a contributor to substandard facility operation, as well as costing more in the long term than routine preventative maintenance.

17.2 Maintenance Records

Maintenance summaries for the individual system components and equipment are provided in the literature prepared by the equipment manufacturers. The manufacturer's O&M instructions and schedules are bound in separate manuals.

NOTE: The operator should refer to that literature for detailed recommendations and instructions for periodic maintenance, lubrication requirements, spare parts, adjustment, and special startup procedures. The following lists are general summaries of the manufacturer's requirements and do not necessarily contain all of the maintenance activities required by the equipment manufacturers for warranty compliance or equipment upkeep.

Each equipment item in the WWTP requiring maintenance should be assigned a number for positive identification and to help ensure all equipment receives proper attention. A simple card file can be used containing pertinent information on each card. An example equipment card is shown on **Table 17-1**.

Table 17-1 - Sample Equipment Card

JAN. 1 2 3 4	FEB. 1 2 3 4	MAR. 1 2 3 4	APR. 1 2 3 4	MAY 1 2 3 4	JUNE 1 2 3 4	JULY 1 2 3 4	AUG. 1 2 3 4	SEPT. 1 2 3 4	OCT. 1 2 3 4	NOV. 1 2 3 4	DEC. 1 2 3 4

Preventative Maintenance Program		Equipment Record Number ____________
EQUIPMENT DESCRIPTION		ELECTRICAL OR MECHANICAL DATA
Name		Size
Serial No.		Model
Vendor		Type
Vendor Address		
Vendor Rep.	Phone	
Initial Cost	Date	

WORK TO BE DONE	FREQUENCY	TIME

DATE	WORK DONE	SIGNED	DATE	WORK DONE	SIGNED	DATE	WORK DONE	SIGNED

17.3 Suggested Maintenance Activities

17.3.1 Daily Maintenance Items

1. Conduct a thorough inspection of the wastewater treatment facility and make any necessary repairs as required by the manufacturer.
2. Check the SCADA System for alarms, warnings, and trends.
3. Collect samples and test as required in the NPDES Permit. Record the data in the daily monitoring report (DMR) as appropriate and record the data on the operational data log.
4. Wash down structures and equipment exposed to wastewater. Avoid direct spraying of electrical panels, motors, etc.
5. Perform required daily housekeeping duties, including sweeping, replacing tools and equipment, gathering and disposing of garbage, and wiping down exposed surfaces.
6. Headworks:
   a. Check position of gates for intended flow scheme.
   b. Inspect composite sampler for proper operation and adequate sample collection. Check sampler temperature for proper sample cooling.
   c. Check screening equipment, clean and discard material as necessary. Clean material from grit bagging system and discard as necessary.
   d. During the winter months, check that the heaters and heat tracing is functioning and the equipment is operating properly.
   e. Verify lighting is fully functional.
7. Primary Clarifiers and Stormwater Clarifiers:
   a. Check for unobstructed flow through the center feed chamber.
   b. Verify scum skimmer operation and pump down skimming tank wet well.
   c. Verify operation of the Primary Solids pumps. Note any observed operating problems (e.g., unusual leaking, vibration, etc.).
   d. Verify lighting is fully functional.
8. Breezeway Pump Station and Recirculation Pumps:
   a. Verify operation of the Breezeway and RAS wetwell recirculation pumps. Note any observed operating problems (e.g., unusual leaking, vibration, etc.).
   b. Check pump housing seals for excessive leakage.
   c. Clean floor area and remove debris.
   d. Verify drain lines from pumps are clear and free of obstructions.
9. Aeration Basins:
   a. Check for unobstructed flow through the influent launder.

b. Check level and appearance of the aeration basins. Note any odors, foaming, or unusual characteristics.

c. Inspect blowers for vibration or unusual noise.

d. Check blower oil level, belt tension, and pressure gages.

10. Secondary Clarifiers:

a. Check for unobstructed flow through the center feed chamber.

b. Verify scum skimmer operation and pump down skimming tank wet well.

c. Verify lighting is fully functional.

11. Biosolids Handling - RAS/WAS Pumps:

a. Verify operation of the RAS/WAS pumps. Note any observed operating problems (e.g., unusual leaking, vibration, etc.).

b. Check pump housing seals for excessive leakage.

c. Verify proper valve settings for intended WAS operation.

d. Clean WAS and RAS basement floor areas and remove debris.

e. Verify drain lines from pumps are clear and free of obstructions.

12. Disinfection System/Outfall:

a. Check water level in the chlorine contact channel (CCC).

b. Inspect the residual sample pump for proper function and positioning in the basin.

c. Check flow condition of the dechlorination spray bar into the effluent channel.

d. During winter months, check that heat tracing is functioning properly.

e. Test gas safety and detection equipment. Verify supply of residual monitoring equipment reagents.

f. Inspect quantity and supply of gas for chlorine and dechlorination systems.

g. Inspect effluent flume and clean as necessary.

13. Gravity Thickener / Solids Transfer Pumps:

a. Check for unobstructed flow through the overflow pipe.

b. Verify operation of the Solids Transfer pumps. Note any observed operating problems (e.g., unusual leaking, vibration, etc.).

14. Rotary Screen Thickener (RST)/ Thickened Sludge (TSL) Pump:

a. Check for polymer level in the polymer feed system.

b. Check polymer feed system pressures and injection nozzle assembly.

c. Verify operation of the RST and remove panels to clean screen element as necessary. Note any observed operating problems (e.g., unusual leaking, vibration, etc.).

d. Verify operation of the TSL pump, feed chute and controls system. Clean inlet chute as necessary. Note any observed operating problems (e.g., unusual leaking, vibration, system pressures, etc.).

15. Anaerobic Digester:
    a. Check digester contents temperature and boiler temperature.
    b. Verify operation of the mixing and sludge feed pumps. Note any observed operating problems (e.g., unusual leaking, vibration, system pressures, etc.).
16. Belt Filter Press:
    a. Check polymer stock tank capacity and feed pumps.
    b. Verify operation of the belt press and progressive cavity feed pumps. Note any observed operating problems (e.g., unusual leaking, vibration, etc.).
    c. Verify operation of the belt press wash water booster pumps. Note any observed operating problems (e.g., unusual leaking, vibration, system pressures, etc.).
17. Reuse Pump Station:
    a. Inspect wet well for accumulated debris and clean as necessary.
    b. Verify operation of the automatic filter and system pressures.
18. Control Building:
    a. Inspect electrical controls, panels, and indicators. Test panel lights as appropriate.
19. Check building room temperatures and operation of HVAC equipment and motorized louvers.
20. Record events throughout the day in the daily log book.
21. File operation and maintenance records.
22. Secure the WWTP by locking all doors and gates that access the Control Building and facility.
23. Record all maintenance activities on the Daily Maintenance Record (see Table 17-2).

    (Table 17-2 is an example sheet developed specifically for the headworks area. Additional sheets can be developed by the Plant Operators and inserted as necessary to record and track maintenance in other areas.)

Table 17-2 - Example Daily Maintenance Record Sheet (Headworks Example)

Date:____________ Weather:____________ Maintenance Personnel:____________

Time:____________

Maintenance Item	Completed (Y/N)	Describe Any Problems	Maintenance Performed to Correct Problems	Maintenance Costs	Comments	Initials
Headworks:						
Check Gates and Flow Scheme						
Sampler Equipment						
Screening Equipment and Channels						
Washing-Compacting Equipment						
Grit Classifier and Grit Aeration Equipment						
Check Foul Air Blower and Biofilter						
Check Heaters and Heat Tracing						
Check Lighting						

17.3.2 Weekly Maintenance Activities

1. Perform recommended daily maintenance activities listed above.
2. Check hours of operation for equipment and record in the Weekly Maintenance Record. Compare hours of operation and time since last servicing to manufacturer's schedule of maintenance. Lubricate and adjust equipment as necessary per the manufacturer's recommendations.
3. Inspect and clean all pumps, pipes, valves, stop gates, and machinery.
4. Manually operate all pumps, pipes, valves, and stop gates.
5. Perform general cleanup of the WWTP grounds:
    a. Cut and remove weeds, if necessary.
    b. Inspect fences for needed repairs and remove accumulated windblown debris.
6. Back up all collected operational data for the preceding week.
7. Anaerobic Digester:
    a. Check digester contents temperature and boiler temperature.
    b. Verify operation of the mixing and sludge feed pumps. Note any observed operating problems (e.g., unusual leaking, vibration, system pressures, etc.).
8. Belt Filter Press:
    a. Check polymer stock tank capacity and feed pumps.
    b. Verify operation of the belt press and progressive cavity feed pumps. Note any observed operating problems (e.g., unusual leaking, vibration, , etc.).
    c. Verify operation of the belt press wash water booster pumps. Note any observed operating problems (e.g., unusual leaking, vibration, system pressures, etc.).
9. Reuse Pump Station:
    a. Inspect wet well for accumulated debris and clean as necessary.
    b. Verify operation of the automatic filter and system pressures.
10. Control Building:
    a. Inspect electrical controls, panels, and indicators. Test panel lights as appropriate.
11. Headworks:
    a. Inspect the composite sampler pump and feed lines for wear and tear. Perform maintenance as recommended in the manufacturer's O&M literature.
    b. Inspect stairs, grating, and railings for structural integrity.
    c. Wash down slab and screening channels to remove accumulated debris. Wash out the bypass channel if any seepage has occurred or if odors are present.
    d. Parshall Flume:
        - Hose down the structure and remove debris, oil, and grease as necessary.
        - Check the transducer readings manually and calibrate as necessary.

12. Primary Clarifiers and Stormwater Clarifiers:
    a. Inspect clarifier drive mechanisms and perform manufacturer's recommended maintenance and lubrication.
    b. Inspect Primary Solids pumps and perform manufacturer's recommended maintenance and lubrication.
    c. Exercise valves.
13. Breezeway Pump Station and Recirculation Pumps:
    a. Inspect Breezeway and RAS wetwell recirculation pumps and perform manufacturer's recommended maintenance and lubrication.
    b. Exercise valves.
14. Aeration Basins:
    a. Inspect the blowers and perform manufacturer's recommended maintenance.
15. Secondary Clarifiers:
    a. Inspect clarifier drive mechanisms and perform manufacturer's recommended maintenance and lubrication.
16. Biosolids Handling – RAS/WAS Pumps:
    a. Inspect RAS/WAS pumps and perform manufacturer's recommended maintenance and lubrication.
    b. Document flow rates and verify operational capacity and operating point on pump curves.
    c. Exercise valves.
17. Disinfection System (CCC/Dechlorination Channel/Effluent Flume):
    a. Check channel for buildup of solids or algae and clean as required.
    b. Hose down the structure and remove debris.
    c. Check the effluent flow meter's transducer readings manually and calibrate as necessary.
    d. Observe the flow over the stainless steel weir and verify the crest is level.
    e. Exercise the slide gates and clean.
    f. Hose down the structure and remove debris.
    g. Inspect the sample pump and feed lines for wear and tear. Perform maintenance as recommended in the manufacturer's O&M literature.
    h. Exercise valves.
18. Gravity Thickener/Solids Transfer Pumps:
    a. Inspect the Solids Transfer pumps and perform manufacturer's recommended maintenance and lubrication.
    b. Inspect gravity thickener skimmer drive mechanisms and perform manufacturer's recommended maintenance and lubrication.
    c. Exercise valves.

19. Rotary Screen Thickening System:
    a. Lubricate the pillow block bearings with good quality, lithium base, EP1 consistency grease
    b. Inspect the oil levels on the SEW Euordrive reducer. Lubricate as recommended in the SEW manuals (bound separately)
    c. Inspect the shower header nozzles for plugging.
    d. Biosolids Handling Floc Tank - Check the level and oil quality in the agitator drive. Change as necessary per manufactures O&M.
20. Anaerobic Digester:
    a. Check digester contents temperature and boiler temperature.
    b. Verify operation of the mixing and sludge feed pumps. Note any observed operating problems (e.g., unusual leaking, vibration, system pressures, etc.).
21. Belt Filter Press:
    a. Check hoses for minor leaks.
    b. Check rollers and bearings for any shaft movement.
    c. Check cylinders and paddle switches for operability.
22. Check safety mechanisms (e.g. stop cord) for proper operation.
23. Reuse Pump Station:
    a. Inspect electrical components for general wear and tear.
    b. Draw down pump wet-well and verify operation of the float control valve.
24. Control Building:
    a. Inspect control panel, VFD fans, SCADA, and filters. Vacuum dust out of the boxes and remove any debris.
25. Gas Purifier:
    b. Verify pH of the system is above 7.0.
    c. Monitor Hydrogen Sulfide Removal; replace iron sponge media as necessary.
26. Emergency Generator:
    a. Check the fuel level in the emergency generator and top off as necessary.
    b. Verify the emergency generator exercised during the week.
    c. Verify transfer switch is operating properly.
    d. Check for any habitation by rodents or insects.
27. Check operating supplies and order, if necessary.
28. Record all maintenance activities on the Weekly Maintenance Record (see **Table 17-3**).

    (Table 17-3 is an example sheet developed specifically for the headworks area. Additional sheets can be developed by the Plant Operators and inserted as necessary to record and track maintenance in other areas.)

Table 17-3 - Example Weekly Maintenance Record Sheet (Headworks Example)

Date:__________ Weather:__________ Maintenance Personnel:__________

Time:__________

Maintenance Item	Completed (Y/N)	Describe Any Problems	Maintenance Performed to Correct Problems	Maintenance Costs	Comments	Initials
Record hours of operation for equipment						
Inspect, and clean valves, and gates						
Manually Operate Pumps, Valves, and Stop Gates						
Backup Collected Operational Data						
Inspect influent composite sampler pump and lines						
Inspect stairs, grating, ladders, and railings						
Wash down Headworks Structure						
Parshall Flume						
Collect samples and perform tests						
Record Maintenance Items						
Check operating supplies and order						
Housekeeping						

17.3.3 Monthly Maintenance Activities

1. Perform recommended daily and weekly maintenance activities listed above.
2. Operate and exercise all valves and slide gates. Lubricate as necessary per manufacturer's recommendations.
3. Perform manufacturer's recommended monthly inspections and lubricant replacement for the bandscreen and screenings washer.
4. Perform manufacturer's recommended monthly inspections and lubricant replacement for the Grit Classifier.
5. Inspect and clean all ventilation screens, openings, MCC cabinet, and electrical boxes, etc.
6. Inspect all HVAC equipment. Perform maintenance as recommended by manufacturer.
7. Inspect all safety and emergency equipment. Charge fire extinguishers and replenish supplies as necessary.
8. Every other month, remove automatic backwashing screen filter element and clean external portion of screen to remove algae build-up.
9. Lubricate rotating equipment per manufacturer's schedule. Perform pump, blower, fan, and motor maintenance as required by the manufacturer's O&M manuals.
10. Inspect roofing, doors, hatches, access panels, and coiling doors per manufacturer's O&M instructions.
11. Prepare, submit, and record monthly discharge monitoring report.
12. Record all maintenance activities on the Monthly Maintenance Record (see **Table 17-4**).

    (Table 17-4 is an example sheet developed specifically for the headworks area. Additional sheets can be developed by the Plant Operators and inserted as necessary to record and track maintenance in other areas.)

Table 17-4 - Example Monthly Maintenance Record Sheet (Headworks Example)

Date:_______________ Weather:______________________________ Maintenance Personnel:____________________

Time:_______________

Maintenance Item	Completed (Y/N)	Describe Any Problems	Maintenance Performed to Correct Problems	Maintenance Costs	Date of Next Maintenance	Comments
Exercise and lubricate valves and gates						
Perform Manufacturers maintenance on , Screenings Washer, and Grit Classifier						
Clean ventilation screens and openings, MCC cabinet, and electrical boxes						
Inspect HVAC equipment						
Inspect safety and emergency equipment						
Lubricate rotating equipment as necessary						
Inspect roofing, doors, hatches, access panels, and coiling doors						
Record Maintenance Items						

17.3.4 Long-Term Maintenance Activities

1. Perform recommended daily and monthly maintenance activities listed above.
2. Headworks:
   a. Perform manufacturer's recommended yearly inspections and lubricant replacement for the JWC Monster Bandscreen and Screenings Washer.
   b. Drain aerated grit chamber and Grit Classifier and clean.
3. Primary Clarifiers:
   a. Drain each clarifier every (6 to 12) months to:
      - Drain, inspect, and clean
      - Remove particulate deposits from the mechanisms
      - Tighten bolts
      - Inspect the mechanism for wear and tear
      - Perform touch-up painting
   b. Drain and replace scraper drive motor oil annually or as required in the manufacturer's O&M manual.
4. Aeration Basins:
   a. Drain the basins and clean (alternating basins)
5. Secondary Clarifiers:
   a. Drain each clarifier every six (6) months to:
      - Drain, inspect, and clean
      - Remove particulate deposits from the mechanisms
      - Tighten bolts
      - Inspect the mechanism for wear and tear
      - Perform touch-up painting
   b. Drain and replace scraper drive motor oil annually or as required in the manufacturer's O&M manual.
6. Rotary Screen Thickening System:
   a. Remove side covers and inspect shafts and drums for excessive or uneven wear on contact surfaces.
   b. Inspect the drum screens for excessive thinning or damage.
   c. Drain the flocculation tank and clean as necessary.
7. Drain and clean chlorine contact and dechlorination basins annually.
8. Perform automatic self-cleaning filter yearly maintenance as required by the manufacturer's O&M manuals.

9. If necessary, dismantle pumps and repair or replace impellers, shafts, shaft supports, seals, and bearings.
10. Inspect all electrical equipment for proper operation and condition and repair and/or replace, if necessary.
11. Paint all equipment, building interiors and exteriors, plant piping, and other structures and equipment, as necessary.
12. Get certified test of RPBAs to verify proper operation.
13. Record all maintenance activities on the Annual Maintenance Record (see **Table 17-5**).

    (Table 17-5 includes the majority of the major annual maintenance areas. Additional sheets can be developed by the Plant Operators and inserted as necessary to record and track maintenance in other areas.)

Table 17-5 - Example Long-Term Maintenance Record Sheet

Date:________________ Weather:______________________________ Maintenance Personnel:____________________

Time:________________

Maintenance Item	Completed (Y/N)	Describe Any Problems	Maintenance Performed to Correct Problems	Maintenance Costs	Date of Next Maintenance	Comments
Perform manufacturer's inspections and lubricant replacement for the Bandscreen, Screenings Washer, and Grit Classifier						
Primary Clarifier: Drain and Clean						
Aeration Basins: Drain and Clean						
Secondary Clarifier: Remove particulate deposits from the mechanisms every 6 months.						
Secondary Clarifier: Tighten bolts every 6 months.						
Secondary Clarifier: Inspect the mechanism for wear and tear every 6 months.						
Secondary Clarifier: Perform touch-up painting every 6 months.						
RST: Inspect Shafts, Drums, and Drum Screens						
Drain and clean chlorine contact basin.						
Drain and clean dechlorination contact channel.						
Automatic Filter: Perform Manufacturer's Maintenance						
Inspect and repair pumps, shafts, seals every 12 months.						
Paint all necessary equipment, buildings, piping, etc. every 12 months.						
Test RPBAs every 12 months.						
Record Maintenance Items						
(Continue on additional sheets)						

17.4 Estimated Staffing Requirements

Based on existing equipment, facilities, and processes at the Sandpoint WWTP, an estimated resource needs matrix was developed, as shown in **Table 17-6**. The estimate reflects routine maintenance on equipment, laboratory work, administration items for permit and regulatory compliance, and other miscellaneous activities at the facility. The estimate should be used as a guideline for facility planning, but site-specific conditions and situations may arise that would result in increased resource demands. Upgrades to the facility may increase or decrease these needs, and a revised estimate should be completed at that time.

Table 17-6 - Estimated Staffing Requirements

	Annual Man-Hours	
	Operations	**Maintenance**
Administration and Supervision	416	
Clerical	416	
Laboratory	2080	
Yard Work (lawns, snow removal)		624
Boyer Lift Station	364	104
Screening and Grit Removal	364	156
Secondary Clarification	364	91
Plant Process Pumping (intermediate)	364	91
Aeration Basins and Blowers	260	91
RAS/WAS Pumping	364	91
Secondary Clarification	260	91
Disinfection	364	91
Dechlorination	364	104
Solids Thickening	364	104
Anaerobic Digester and Equipment	364	104
Belt Filter Press/Solids Handling	624	312
Plant Reuse Water System	182	312
Subtotals	**6,344**	**1,638**
	TOTAL	**7,982**
	Number of Employees[1]	**4.26**

[1] *Based on 2,080 hours per year per employee, the effective working time is estimated at 90%, with the remaining 10% representing paid vacations, holidays, sick leave, and other paid time away from the job. This leaves 1,872 effective hours per employee per year.*

Chapter 18

Laboratory Monitoring, Sampling, and Record Keeping

Chapter 18 – Laboratory Monitoring, Sampling, and Record Keeping

18.1 General

To provide a final effluent that will meet state and federal effluent standards, sampling and testing of the wastewater during different stages of treatment are required. Laboratory results should be kept and summarized as a permanent record of the performance of the WWTP.

18.2 Laboratory Facilities and Equipment

The Sandpoint WWTP laboratory is located in the existing Control Building. Maintain the equipment in the laboratory to assure accurate and reliable testing. Improper analysis of the WWTP samples may result in permit violations or misdiagnosed operating characteristics.

18.3 Monitoring Requirements for Permit Compliance

Monitoring is required for the following reasons:

- To provide the state environmental agency, Idaho Department of Environmental Quality (IDEQ), with information required in the NPDES discharge permit.
- To form a rational basis for the control of treatment plant processes.
- To define the operational efficiency of the plant and its components.
- To obtain a historical record of the conditions under which the plant has been operated, as an aid to the design of the plant expansion or modification, and as a budgetary aid.
- To assist operating personnel in locating and solving operational problems.
- To provide valuable information for release to the public.
- To aid in any legal action.

IDEQ's requirements for monitoring are summarized in the City's NPDES Permit, included in **Appendix A**. The permit lists each test required and the associated sampling point, sampling frequency, and sample type. In addition to the tests required in the permit, operators should perform other tests for operational and informational reasons as listed above.

Table 2-2 described the receiving water testing requirements, which would satisfy the existing discharge permit requirements and provide additional information to operate the plant. The tests and sampling types are discussed in further detail later in this section.

18.4 Tests and Measurements for Permit Compliance

All tests should be conducted in accordance with the American Public Health Association, Standard Methods for the Examination of Water and Wastewaters, latest edition, or Guidelines Establishing Test Procedures for the Analysis of Pollutants, contained in 40 CFR

Part 136, as published in the Federal Register, October 16, 1973, or as thereafter amended. The following paragraphs briefly describe each test that is listed in the above table.

Flow: The wastewater flow is typically expressed in units of million gallons per day (mgd) and is measured by the influent and effluent flow meters. It is an important parameter for determining how heavily the WWTP is loaded. The average, maximum, minimum and total flow is important information to record.

pH: The pH is a unitless measure of the acidity or hydrogen ion concentration of the wastewater and is measured with a laboratory pH meter. A low pH is acidic, a high pH is basic, and a pH of 7.0 is neutral. Process the sample as soon as possible after obtaining it. It is an important parameter in monitoring the chemical and biological reactions occurring in the treatment process.

DO: The dissolved oxygen (DO) concentration is expressed in mg/L or ppm and is measured with a laboratory DO meter. The measurement should be made as soon as possible after obtaining the sample. It is an important parameter in monitoring the effectiveness of aeration and determining if the wastewater is aerobic or anaerobic. Standard Methods SM 4500 G discusses testing procedures.

BOD: The biochemical oxygen demand (BOD) is expressed in mg/L or ppm and measures the "strength" of the wastewater. The BOD testing measures the amount of oxygen that microorganisms will consume during oxidation and stabilization of the organic matter in the wastewater. It is measured by a 5-day laboratory test procedure described in Standard Methods SM 5210.

TSS: Total Suspended Solids (TSS) is expressed in mg/L or ppm and measures the amount of residue that would be left over if a filtered sample of wastewater was evaporated. See Standard Methods SM 2540 D for test procedure.

Temperature: The temperature of the wastewater can be measured with a standard laboratory thermometer in degrees Fahrenheit or Celsius. It is an important parameter because of its effect on chemical reactions, biological activity, and river water quality.

Total Chlorine Residual: The Total Chlorine Residual (TCR) is expressed in mg/L or ppm and measures the chlorine concentration still present in the wastewater after disinfection in the Chlorine Contact Chamber. See Standard Methods SM 4500-C1 G for testing procedures.

Fecal Coliform: Fecal coliform is a type of bacteria found in the gut of warm-blooded animals, especially humans. The presence of these bacteria is used as an indicator for the presence of other pathogenic bacteria, viruses, and fecal pollution, and is a measure of the effectiveness of the disinfection system. See Standard Methods SM 9222 D for the testing procedures.

18.5 Tests and Measurements for Operational Control

Basic Operation and Testing: The aeration basin plant has gained acceptance because of its ability to handle peak and shock loadings. These factors and the comparative simplicity of structures and equipment reduce the necessity for advanced technical operation supervision.

However, do not ignore the periodic laboratory tests conducted to determine the actual operating efficiency. These tests include BOD, suspended solids, settleable solids, total solids, pH, dissolved oxygen, and fecal coliform examinations as described and discussed in Chapter 6 of this manual. Some tests that are clear indicators of plant operation are analyzed in detail in the following sections.

Settleable Solids Tests: The most important simple test for optimum operation is the settleable solids test of aeration basin effluent. When the plant is operating properly, the mixed liquor sample will have a dense sludge and clear supernatant, and the clarifier effluent sample will show a slight dusting of sludge settling on the bottom with some light suspended floc in the supernatant. Clarity in the clarifier effluent sample is an excellent indicator of good operation. If the plant is operating poorly, the sample may or may not have a dense settling sludge, but it will show a turbid supernatant above the settled sludge. If the supernatant of the aeration basin influent is clear and the supernatant of the clarifier effluent is turbid, the problem is in the clarifier. The usual cause is septic sludge in the clarifier. This could be a clogged return sludge line or sludge pockets hanging on the walls of the clarifier.

If the aeration basin sample solids look black and the sample has a rotten-egg odor together with a turbid supernatant, the system is not receiving enough oxygen and aeration must be increased. It is also possible that the oxygen demand of the incoming sewage has increased. Complete laboratory tests should be conducted to verify this fact.

The volume of solids measured in the settleable solids test in the aeration basin should be noted and recorded. The volume of solids should increase over time. When the volume reaches approximately 60 percent, the sludge should usually be wasted. By noting the rate of solids gain over several weeks, the operator can set up a schedule for removal of excess solids. Excess sludge should also be removed if there is an increase in settleable solids in effluent samples.

Dissolved Oxygen Test: The dissolved oxygen (DO) test is another simple test that can be used as an indicator of plant efficiency and control operation. The DO in the aeration basins should be maintained automatically by adjusting blower speed through the PLC, but should also be checked manually to verify the equipment is still operating properly.

pH Test: Checking the pH is another of the simple tests. The pH test should be made on the raw waste and the aeration basin contents. Most microorganisms that are used in the aeration basin to treat sewage cannot tolerate pH levels above 9.5 or below 6.5. pH levels outside this range can cause deterioration in treatment plant performance most frequently resulting in a cloudy effluent or sludge bulking.

The pH of the influent should be near 7.0 if the raw waste is normal domestic sewage. A substantial variation (a pH of less than 6 or greater than 8) would normally indicate an industrial discharge of acid or alkalis. Any rapid change in pH is a good indicator of potential problems and should be investigated. Excessive nitrification can also cause the pH to lower. The pH value should be recorded after each test so that changes in the plant can be observed early and steps can be taken to correct the upset before serious problems arise. Plant pH should be monitored and different times of the day to account for diurnal flow/load variations.

Mixed Liquor Suspended Solids Test (MLSS): While not as essential to plant operation as the settleable solids test, the MLSS test also provides the operator with an excellent means of determining proper sludge wasting times and rates. The test will also help identify a bulked sludge condition.

The aeration basin will typically operate with an MLSS content of 1,500 to 4,000 mg/L, although most plants we are familiar with are in the lower end of that range. By plotting the aeration basin MLSS levels, the operator can establish a sludge wasting schedule based on the rate of solids buildup. The operator can also assess the impact snow melts, etc. have on the plant (i.e., solids washout) and increase the sludge return rates during such times, if necessary. The optimum MLSS level for the Sandpoint WWTP can be determined only from the plant operations experience. We would suggest the plant be operated with an MLSS of 2,000 mg/L and adjusted as discussed elsewhere in this manual.

Volatile Suspended Solids (VSS): The VSS portion of the total suspended solids is typically 80 percent. It is important to identify the volatile portion of the total suspended solids since this value more closely identifies the food portion of the total suspended solids. If the VSS is less than 80 percent of the MLSS, a substantial portion of the mixed liquor is inert. This indicates that the operator should consider additional wasting. Appropriate revisions in the values discussed elsewhere in this manual should be revised.

F/M Ratio: The food to microorganism (F:M) ratio is a term often used to describe the loading of the aeration basin relative to the biomass. F:M is defined as the pounds of BOD (food) applied per day divided by the pounds of mixed volatile liquor suspended solids in the aeration basin. This ratio for an aeration basin is typically 0.05 to 0.30.

Solids Retention Time (SRT): SRT is also known as the "Mean Cell Residence Time" (MCRT) and as the "sludge age." The biological organism synthesis (proportional to BOD removed) is known as the cell or sludge yield. Cell or organism losses are generalized as endogenous respiration. Since organism growth generally occurs only under aerobic conditions, the SRT is calculated based on the amount of organisms in the aeration basin and does not include the organism mass in the anaerobic or anoxic basins. SRT is the mixed liquor solids divided by the sludge (cell) wasting rate—typically from 5 to 30 days.

Residual Chlorine Test: It is necessary to chlorinate the effluent from the plant for disinfection purposes. There are three reasons for the test. First, too little chlorine in the plant effluent will not properly disinfect the effluent. Second, too much chlorine may harm aquatic life in the receiving waters and violate the discharge permit. Finally, too much chlorine is wasteful and costly. Residual chlorine test kits are available from many sources. The chlorinator should be set so the residual chlorine in the effluent prior to dechlorination is less than 1.0 mg/L to maintain adequate disinfection, while after dechlorination, the residual chlorine should be less than 0.45 mg/L per the NPDES Permit as discussed in **Chapter 2** and **Appendix A**.

Records: A daily log sheet included in the appendices should be kept with notations made of all WWTP operations. This can be a very simple form. The operator should record settleable solids test, DO tests, MLSS, VSS, F/M Ratio, pH, color, odor, and the date sludge is wasted.

These records are helpful for determining operating procedures and in evaluating plant performance. Many times, the log information may point to a cause of operation difficulties.

18.6 Sample Techniques and Types

Proper sampling techniques are as important as analytical techniques. Take care to ensure that the sample obtained is representative. Samples should be free of large particles and materials that have grown or accumulated at the sampling point. Analyze all samples as soon as possible after they are obtained and should be refrigerated during the interval between sampling and analysis to minimize changes due to biological action.

There are three main types of sampling:

Grab: Grab samples are single samples taken at an instant in time. They offer a "snapshot" view of the wastewater conditions. If grab samples are to be taken at several different locations, the samples should all be taken at the same instant in time so that they can be correctly compared.

Composite: Composite samples consist of multiple sub-samples taken at the same location to represent the average condition over a specific time period. For example, a 24-hour composite sample of the effluent could be obtained by collecting a small volume of effluent each hour for 24 hours and then combining all the collected portions into one sample for testing.

Analysis of the wastewater flow (raw influent and final effluents), insofar as possible, should be based on composite samples. Without full-time plant attendance, composite sampling is limited to mechanical sampling on a 24-hour basis or to hand sampling during the normal day shift.

On-Line: On-line sampling is performed by continuously monitoring a parameter. Continuous flow measurement at the influent and effluent is an example of on-line sampling.

The Sandpoint WWTP has two automatic wastewater samplers, one for influent and one for effluent. The samplers have pumps that obtain wastewater samples and keep them refrigerated. The pumps purge the sample lines prior to taking samples. A more complete discussion of the samplers may be found in the manufacturer's O&M literature.

18.7 Record Keeping and Reporting

Historic records of plant operating parameters serve as a valuable tool in maintaining plant effluent quality and in monitoring trends. Operator reports also provide valuable information such as electrical power consumption, weather conditions, labor time, cost, and performance of mechanical equipment; and quantities of chemicals and other supplies used. In addition to providing valuable data on plant operation, these reports provide information for performance evaluation and for inspection by regulatory agencies.

Daily and monthly laboratory summaries provide a permanent record of all laboratory work performed. When properly completed, these records serve as a basis for the monthly operation report. Since no major unit processes have been added with these improvements and the City has been satisfying the regulatory agencies' record keeping practices, no modifications to the forms currently used are warranted. It is suggested that the City's current forms be added to the end of this manual in a separate section. These forms, along with the IDEQ monthly report forms, should be kept as original and photocopied for record keeping and reporting.

The City's NPDES Permit lists the reporting requirements. This section should be carefully studied and followed to ensure compliance with the permit. As permit requirements change, the City will have to update and modify their forms appropriately.

18.8 Laboratory Reference Materials

Specific information regarding the methods of performing the various tests and analyses at the treatment plant can be found in several publications. Some of the references that will be of value to the operator are:

- *Simplified Laboratory Procedures for Wastewater Examination*, Third Edition, 1985, Water Pollution Control Federation (WPCF) Publication #18.
- *Standard Methods for Examination of Water and Wastewater*, APHA-AWWA-WPCF, 19th Edition, 1996, or latest edition.
- *Chemistry for Sanitary Engineers*, Sawyer, McGraw-Hill.
- *Operation of Wastewater Treatment Plants*, WPCF Manual of Practice No. 11.

Chapter 19

Emergency Operations

Chapter 19 – Emergency Operations

Operation and maintenance personnel must be familiar with emergency plans and procedures for the wastewater treatment system and understand their duties for all emergency situations so the appropriate steps can be taken. This section describes the steps that should be taken if one of the following emergency situations develops:

1. Electrical power failure
2. Natural disasters

If an emergency occurs, contact the City Public Works Department immediately. A list of City personnel with day and night telephone numbers should be maintained at each telephone location at the WWTP, the City Public Works Office, and other City controlled and operated facilities.

19.1 Electrical Power Failure

The treatment plant is equipped with two generators. The first 330 kW diesel standby generator powers the main portion of the plant, including the Headworks, Blower, and Chlorine Buildings and is located in the Digester Control Building. The second 76 kW natural gas standby generator powers the Control Building and the primary pump systems and is located in Primary Plant Control Building. In the event of a power failure, the following sequence of events will occur:

1. The ATS (for each generator) will sense the loss of utility power and call the generator to start.
2. After a warm-up period and after sensing proper phase and voltage is available from the generator, the ATS will switch over to the generator power.
3. The generator will power the plant during the utility power loss period. The generator is sized to allow full plant operations for the current plant loads.
4. Upon return of utility power for a programmable period of time, the ATSs will switch back to the utility power position.
5. After a cool-down period, the generators will shut down and ready itself for the next start.

The generators are programmed to exercise automatically on a weekly basis. The generators may also be exercised manually from the front panel of the ATSs.

There are manual settings inside the ATS to control the time delays between all of the ATS operations.

See the generator O&M manual for detailed settings information for the generator and the ATS.

Upon power outage, the operator will want to follow the following steps:

1. Contact Avista Utilities immediately and notify them of the power outage.

2. Observe the generator for proper operation.
3. Monitor fuel consumption and replenish as necessary.
4. Observe the PLC for proper operation.
5. Check other critical components of the treatment plant for proper operation as appropriate during a power outage.
6. Record information about the power failure on the daily operation log. Include date and time of failure, duration, steps taken to restore power, any problems observed during the failure, and steps taken to resolve those problems.

19.2 Natural Disasters

Although natural disasters such as tornadoes, earthquakes, blizzards, or floods are relatively uncommon in Sandpoint, their occurrence could disrupt the operation of the WWTP. Therefore, O&M personnel should be prepared to take appropriate action during such emergencies.

Immediately after any natural event with unusually heavy rains or windy conditions, operators should carefully inspect the WWTP. Any change in normal appearance or identifiable damage to the WWTP should be noted in the daily diary, and the Public Works Director should be informed of the condition. Potentially dangerous or life-threatening conditions should be remedied immediately. Photographs of the area can also be of value should the conditions continue to change.

A summary of potential natural disasters along with general guidance follows.

19.2.1 Blizzards or Heavy Snowfall

The structural design of the plant structures took into account snow loads expected in this area. Ice around the structures should be broken to reduce ice pressure and keep the channels open.

If a blizzard or heavy snowfall were to make it impossible for key personnel to get to the treatment plant, it is expected at least one member of the staff should be able to reach the facility and operate it. This type of emergency demonstrates why every employee of the City should be familiar with the treatment plant's operation.

19.2.2 Chlorine Emergency Measures

General: As soon as there is any indication of the presence of chlorine in the air, immediate steps should be taken to correct the condition. Chlorine leaks never get better; they always get worse due to corrosion if they are not promptly corrected. When a chlorine leak occurs, authorized, trained personnel equipped with suitable air packs should investigate and take action. Whenever possible, no person should work alone on a chlorine leak. All other persons should be kept away from the affected area until the cause of the leak has been discovered and the trouble corrected. If the leak is extensive, all persons in the path of the fumes must be warned to leave the area. Keep upwind of the leak and above it. Because chlorine gas is approximately 2½ times as heavy as air, it usually lies close to the ground; however, this may not be true inside buildings or where local air currents are present.

Emergency Assistance: If a chlorine emergency cannot be handled promptly by personnel at the site, call the nearest office or plant of the supplier for assistance. If the supplier cannot be reached, call the nearest chlorine producing plant where help is available. Chlorine producing plants operate around the clock and can be reached by telephone at any time. The telephone numbers of the supplier of the nearest chlorine producer who is able to provide assistance in an emergency should be posted in a suitable place so that they will be quickly available if needed; these should be checked periodically to insure accuracy.

When phoning for assistance, give the following:

- Name of chlorine supplier
- Your facility name, address, telephone number, and the person or persons to contact for further information
- Travel directions to emergency site
- Type and size of container
- Nature, location and extent of emergency
- Corrective measures being applied

Fires: In case of fire, chlorine containers should be removed from fire zone immediately. If no chlorine is escaping, water should be applied to cool containers that cannot be moved. All unauthorized personnel should be kept at a safe distance.

Leaks: To find a leak, tie a cloth to the end of a stick, soak the cloth with aqua ammonia, and hold close to the suspected area. A white cloud will result if there is any chlorine leakage. Avoid contact of ammonia with brass. Commercial strength (26° Baume) aqua ammonia should be used (household ammonia is not strong enough).

Never use water on a chlorine leak. Chlorine is only slightly soluble in water; also, the corrosive action of chlorine and water will always make a leak
If a leak occurs in equipment or piping, shut off the chlorine supply, relieve the pressure, and make necessary repairs. If welding is needed, purge the system with dry air (nitrogen or carbon dioxide also may be used) before proceeding. Welding should comply with all applicable codes.

Leaks around valve stems usually can be stopped by tightening the packing gland or packing gland nut by turning clockwise. If this does not stop the leak, the container valve should be closed; if it does not shut off tight, the outlet cap or plug should be applied.

Container Leaks: These additional actions may be taken to contain and control leaks:

1. If a container is leaking chlorine, turn it if possible so that gas instead of liquid escapes. The quantity of chlorine that escapes from a gas leak is about one-fifteenth the amount that escapes from a liquid leak through the same size hole.
2. It may be desirable to move the container to an isolated spot where it will do the least harm.

3. If practical, reduce pressure in the container by removing the chlorine as gas (not as liquid) to the chlorine mixing basin.
4. Apply emergency repair kit device.
5. Never immerse or throw a leaking chlorine container into a body of water; the leak will be aggravated and the container may float when still partially full of liquid chlorine, allowing gas evolution at the surface.
6. Call for emergency assistance.

It is illegal to ship a leaking chlorine container or a container that has been exposed to fire, whether full or partially full. However, it may be desirable under some circumstances to ship a defective chlorine container to which an emergency device has been applied. Consult your chlorine supplier.

Emergency Kit: Emergency kits have been designed to contain most leaks that may be encountered in chlorine shipping containers. These kits operate on the principle of capping off leaking valves or, in the case of cylinders and ton containers, of sealing off a leak in the side wall. Capping devices are provided for fusible plugs in ton containers.

19.2.3 Sulfur Dioxide Emergency Measures

General: As soon as there is any indication of the presence of sulfur dioxide in the air, immediate steps should be taken to correct the condition. Gas leaks never get better; they always get worse due to corrosion if they are not promptly corrected. When a gas leak occurs, authorized, trained personnel equipped with suitable air packs should investigate and take action. Whenever possible, no person should work alone on a sulfur dioxide gas leak. All other persons should be kept away from the affected area until the cause of the leak has been discovered and the trouble corrected. If the leak is extensive, all persons in the path of the fumes must be warned to leave the area. Keep upwind of the leak and above it. Because sulfur dioxide gas is approximately 2½ times as heavy as air, it usually lies close to the ground; however, this may not be true inside buildings or where local air currents are present.

Emergency Assistance: If a sulfur dioxide emergency cannot be handled promptly by personnel at the site, call the nearest office or plant of the supplier for assistance. If the supplier cannot be reached, call the nearest chlorine producing plant where help is available. Sulfur Dioxide producing plants operate around the clock and can be reached by telephone at any time. The telephone numbers of the supplier of the nearest chlorine producer who is able to provide assistance in an emergency should be posted in a suitable place so that they will be quickly available if needed; these should be checked periodically to insure accuracy.

When phoning for assistance, give the following:

- Name of sulfur dioxide supplier
- Your facility name, address, telephone number, and the person or persons to contact for further information
- Travel directions to emergency site
- Type and size of container

- Nature, location and extent of emergency
- Corrective measures being applied

Fires: In case of fire, sulfur dioxide containers should be removed from fire zone immediately. If no sulfur dioxide gas is escaping, water should be applied to cool containers that cannot be moved. All unauthorized personnel should be kept at a safe distance.

Leaks: To find a leak, tie a cloth to the end of a stick, soak the cloth with aqua ammonia, and hold close to the suspected area. A white cloud will result if there is any chlorine leakage. Avoid contact of ammonia with brass. Commercial strength (26° Baume) aqua ammonia should be used (household ammonia is not strong enough).

Never use water on a sulfur dioxide gas leak. Sulfur Dioxide is only slightly soluble in water; also, the corrosive action of sulfur dioxide gas and water will always make a leak due to the creation of sulfuric acid. If a leak occurs in equipment or piping, shut off the chlorine supply, relieve the pressure, and make necessary repairs. If welding is needed, purge the system with dry air (nitrogen or carbon dioxide also may be used) before proceeding. Welding should comply with all applicable codes.

Leaks around valve stems usually can be stopped by tightening the packing gland or packing gland nut by turning clockwise. If this does not stop the leak, the container valve should be closed; if it does not shut off tight, the outlet cap or plug should be applied.

Container Leaks: These additional actions may be taken to contain and control leaks:

1. If a container is leaking sulfur dioxide, turn it if possible so that gas instead of liquid escapes. The quantity of sulfur dioxide that escapes from a gas leak is about one-fifteenth the amount that escapes from a liquid leak through the same size hole.
2. It may be desirable to move the container to an isolated spot where it will do the least harm.
3. If practical, reduce pressure in the container by removing the sulfur dioxide as gas (not as liquid) to the sulfur dioxide mixing basin.
4. Apply emergency repair kit device.
5. Never immerse or throw a leaking container into a body of water; the leak will be aggravated and the container may float when still partially full of liquid sulfur dioxide, allowing gas evolution at the surface.
6. Call for emergency assistance.

It is illegal to ship a leaking sulfur dioxide container or a container that has been exposed to fire, whether full or partially full. However, it may be desirable under some circumstances to ship a defective container to which an emergency device has been applied. Consult your gas supplier.

Emergency Kit: Emergency kits have been designed to contain most leaks that may be encountered in sulfur dioxide shipping containers. These kits operate on the principle of capping off leaking valves or, in the case of cylinders and ton containers, of sealing off a leak in the side wall. Capping devices are provided for fusible plugs in ton containers.

19.2.4 Equipment Failure

The continuous operation of most of the treatment facility operations is essential to proper plant efficiency. For this reason, most unit operations are equipped with redundant equipment, and the plant is served by an emergency generator capable of running critical units to maintain treatment of incoming wastewater. Most plant components can be bypassed by opening and closing various pipe lines.

The chlorination equipment has been provided in duplicate. If the chlorination equipment fails for some reason, the service representative should be called.

The failure of any non-essential piece of equipment provided with a backup will not create an emergency condition unless the condition exists over a long period of time, but may involve some inconvenience until repaired. All equipment should be placed back in service as soon as possible.

19.2.5 Treatment Facility Upset

The EPA Manual titled "Process Control Manual for Aerobic Biological Wastewater Treatment Facilities" has a complete troubleshooting section that should be referred to for specific information in the case of plant upset.

A large array of substances detrimental to the treatment process may be dumped into the sewer system. These substances will usually be evident at the treatment facility by an unusual odor or color or a decrease in plant efficiency.

An investigation of the MLSS in the aeration basin may help identify the source of the treatment facility upset. Once the foreign substance is identified, the Utilities Department Superintendent should attempt to identify the source of the foreign material. If the source can quickly be identified, the discharger should be notified of the illegal discharge and the possible consequences if it is not eliminated. If, on the other hand, it is a widely used product (for example, fuel oil) and it is impractical to identify the source, the foreign substance should be reported to local authorities for their investigation.

The plant operator should be familiar with industrial dischargers or facilities that could potentially discharge solvent-type wastes to the sanitary sewer. The operator should also familiarize themselves with the types of chemicals used in these facilities and how they may impact the biological treatment process. If the operator suspects the discharge of harmful chemicals into the sanitary sewer system, the Idaho DEQ should be notified immediately for enforcement assistance.

19.2.6 Emergency Readiness Program

There are four basic elements to any sound emergency response plan:

1. Rapid and positive detection system
2. Response procedure with predetermined patterns of action
3. Backup capability in the event that the local response capability proves insufficient

4. Warning system to alert the next level of responsibility that an emergency condition exists

An emergency condition affecting a municipal wastewater collection and treatment system generally results in a spill of raw or inadequately treated wastewater. These spills can be placed in two major categories—treatment problems and collection line problems. An emergency response plan must be developed for both conditions. The following items should be considered in the development of the response plans:

- Training and rehearsal of emergency plans is important for all plans. An essential part of any rehearsal is the review that follows the training session. Comments and information from these rehearsals will ensure that the plan remains operational.
- Standby equipment will be put into service periodically as part of the overall response training program.
- A suitable spare parts inventory will be maintained to avoid unnecessary delivery delays and provide components needed during emergencies. In addition to parts, sections of pipe will be stocked and repair crews rehearsed to provide quick response to collection line breaks.
- A list of mobile gasoline-powered pumps available to respond to emergencies resulting from pump, or control, or system emergencies will be maintained.
- A complete set of As-Built Drawings of the facility is available. During emergencies, these drawings may be invaluable in locating valves, electrical boxes, etc. that are needed to minimize effects of incident.

The following response procedures are generally applicable to efforts under most circumstances:

- Take time to analyze the emergency to determine the proper course of action.
- Implement protection measures where applicable.
- Dispatch a pre-trained crew if available.
- Check spare parts inventory first before ordering parts.
- Take a piece of equipment or unit process out of operation only as a last resort.
- Keep "down time" to a minimum.

Except for the chlorinator, and electrical and operational controls, the process can be temporarily maintained in spite of several equipment outages. The City should maintain an initial spare parts inventory of such items as seals, gaskets, and electrical relays and components necessary for routine maintenance. With operating experience, it can be determined what additional parts need replacing and these can be added to the initial inventory and stock.

All personnel should be familiar with this manual and the equipment manuals (bound separately), know where they are kept, and be briefed on procedures essential to a safe, efficient operation.

Local Fire Department officials should visit the treatment facility and make recommendations on ways to minimize fire hazards. The Fire Department should also be asked to routinely check fire extinguishers, wiring, and combustible material storage areas.

The chlorine and sulfur dioxide system should be studied by both Fire Department officials and treatment system personnel. Coordination with the Fire Department is essential for responding to emergencies involving chlorine gas or sulfur dioxide, and the Fire Department must be provided with plans of all of the treatment facility to aid them in responding to potential fires within the treatment facility.

19.3 Emergency Contact List

Table 19-1 outlines emergency contacts and phone numbers that should be posted near telephones and carried by personnel with mobile telephones.

Table 19-1 - Emergency Contact List

Emergency Contact	Telephone Number
City of Sandpoint	
Public Works Office	208-263-3407
Wastewater Treatment Plant	208-263-3433
Maintenance Shop	208-263-3428
Police	208-263-3105
Water	208-263-3440
Police (Bonner County Sheriff)	208-263-8417
Ambulance	911
Fire Department	208-263-3502
Avista Utilities	
Buried/Overhead Power	800-824-9763 ext. 6951
Natural Gas	800-824-9763 ext. 6951
Idaho Department of Environmental Quality	
John Tindall	208-769-1422
Panhandle Health District	208-263-5159
Frontier (telephone)	1-800-483-5000
One Call	811

Chapter 20

Safety

Chapter 20 – Safety

The Sandpoint WWTP endeavors to provide safe working conditions and promote safety consciousness among employees to reduce accidents and personal injuries. To this end, all work associated with operation and maintenance of the wastewater treatment system shall conform to the applicable federal, state, and local safety regulations.

20.1 Causes and Prevention of Accidents

The major causes of accidents at wastewater treatment facilities may be generalized as follows:

Failure of the person in charge to:

- Give adequate instructions
- Make thorough inspections and investigate follow-up action
- Assign safety responsibilities
- Check equipment and safety devices before commencing tasks
- Plan safety procedures for proposed activities
- Use safe methods and follow safety rules
- Use experienced or skilled employees
- Maintain discipline and enforce safety rules
- Require reasonable working hours

Failure of employees to:

- Observe established safety rules and practices
- Use equipment at rated speeds or follow other instructions
- Get permission to perform work not regularly assigned
- Use protective devices or equipment
- Properly use tools, equipment, or materials suitable for the work to be performed
- Work as a team on tasks

The mental attitude or physical condition of the employee, such as:

- Divided attention or inability to concentrate
- Lack of knowledge or comprehension
- Failure to use good judgment
- Tendency to hurry a job or take hazardous shortcuts
- Inability to work with others (anger or impulsive action)
- Excitement, fright, and other involuntary reactions
- Physical handicaps or lack of strength
- Conditions caused by allergies
- Reduced human reliability due to environmental pollutants, such as excessive noise or exposure to hazardous gases or fumes

20.2 Safety Hazards

Typical safety hazards associated with the operation and maintenance of a WWTP are discussed in the following sections. OSHA requirements for confined space entry are included in **Appendix B** and OSHA lock-out/tag-out procedures are included in **Appendix C**. These items are discussed in the following sections. Specific hazards associated with the system components are addressed in the manufacturer's literature.

20.2.1 Blood Borne Pathogens

Personnel performing operation and maintenance on the wastewater treatment system have the potential of exposure to blood borne pathogens, including, but not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV). All O&M personnel should received HBV and tetanus shots. All personnel should be trained on methods to reduce the acquisition and transmission of blood borne pathogens. These methods include:

- Medical abatement through vaccinations and inoculations
- Maintaining good personal hygiene
- Utilizing the appropriate personal protective equipment
- Decontaminating or disposing of contaminated equipment
- Education and training

20.2.2 Personal Hygiene

Cleanliness is basic to good health and is of critical importance to those persons working with wastewater facilities. Infection and disease are a constant threat to the employee and those with whom he/she associates. A number of diseases are transmitted by wastewater that passes through the treatment system. To avoid infection, personal protective equipment (i.e., rubber gloves, rubber footwear, eye protection, coveralls, hard hat, etc.) must be used. Frequent changes in personal protective equipment and clothing will help prevent transmission of infection or disease to other persons. Contaminated personal protective equipment should be disposed of, or thoroughly decontaminated prior to re-use.

After coming in contact with wastewater or contaminated equipment, all exposed skin should be thoroughly washed. Protective waterproof dressings should be worn to prevent open cuts or wounds from coming in contact with wastewater or contaminated equipment. If contact occurs, wash the area thoroughly in clean water containing either a weak solution of disinfectant or a good antiseptic, sponge the area with an antiseptic solution, and cover it with a clean, dry dressing and waterproof adhesive. If penetration is more than superficial, see a doctor as soon as possible. In the event of deep wounds, the employee should get a tetanus booster within 48 hours. Bandages covering wounds should be changed frequently.

"Keep your hands below your collar" is a good rule to follow while working in sewers and while handling wastewater. Since many infections reach the body by way of the mouth, nose, eyes, and ears, the hands should be thoroughly washed prior to smoking, eating, or drinking. Any illness or symptom, such as dysentery or stomach pain, should be reported immediately.

20.2.3 Physical Injuries

Physical injuries may occur as a result of improperly lifting objects, lifting objects that are too heavy, over-reaching, slips, trips, and falls. These hazards may be mitigated by properly training O&M personnel, including:

- The proper techniques for lifting objects
- Providing the appropriate equipment for lifting heavy objects
- Good housekeeping procedures
- Identifying, marking, or limiting access to hazardous areas
- Providing the appropriate personal protective equipment

The improper handling of materials can be a significant cause of injury to personnel. Poor handling practices can lead to hernias, back strains, crushed toes, lacerations, and other injuries. Ensure that adequate help is available, use the proper equipment when moving or installing equipment, and wear personal protective equipment.

Before lifting an object, ensure that the surface is free of oil, grease, or other substances that could make the object slippery. Check the floor to ensure that no obstructions are in the way and the path is clearly visible. Set feet and take a firm grasp that can be retained if the center of gravity of the object shifts. Lift the object from a squatting position with the back straight and the legs exerting most of the lifting force. Lift smoothly and evenly, and avoid twisting the body. Any lift that requires excessive exertion must not be attempted without assistance. The load should be carried as close to the body as possible, and the grip should not be shifted.

20.2.4 Hazardous Gases and Vapors

Sewer gas (which includes a variety of gas mixtures) is found in wastewater collection lines and manholes, and other confined areas within the treatment system. The sewer gas typically contains high percentages of carbon dioxide, varying amounts of methane, hydrogen, and hydrogen sulfide, and low percentages of carbon monoxide, nitrogen, and oxygen. Such a mixture of gases accumulates in the system as the result of fermentation or decomposition of organic matter in the wastewater.

These noxious gases are harmful to human health, and O&M personnel must be aware of the potential hazards, including:

- Flammability
- Suffocation
- Poisoning

A gas may exhibit any one or all three of the hazards listed above. Typically, the greatest hazard comes from the displacement of oxygen in the area where work is being conducted, causing suffocation if the area is entered without proper ventilation. Some of the gases, such as methane, are explosive when present in a proper ratio to oxygen. As a result, O&M personnel should never smoke, drop lighted matches, or use an open flame in or around sewers. In addition, personnel must follow all appropriate confined space entry requirements (i.e., air monitoring, ventilation, rescue equipment, buddy system, etc.) prior to entering a space in the sewer system that meets the confined space definition (see **Appendix B**).

Gasoline and petroleum vapors in the sewer system normally result from the accidental or illegal entry of gasoline or other hydrocarbons. Illegal entry of gasoline or petroleum does not happen frequently. However, the fire department must immediately wash down a street where gasoline or petroleum products were spilled accidentally. This can result in flammable product entering the sewer system.

The greatest hazard associated with petroleum product vapors is explosion. City personnel should never smoke, drop lighted matches, or use an open flame in or around sewers. Two conditions must be present to cause a gas explosion—a sufficient concentration of gas/air mixture to support combustion and a source of heat greater than the ignition temperature of the gas/air mixture.

In confined areas of wastewater facilities, explosive gas mixtures may develop from mixtures of air and methane, natural gas, manufactured fuel gas, or gasoline vapors. Explosive ranges can be detected by using a combustible gas indicator. Explosions can be avoided by providing adequate ventilation to the area with fans or blowers, and by keeping open flames away from areas capable of developing explosive mixtures.

20.2.5 Chemical Handling

Improper handling or control of hazardous chemicals or waste can result in a severe threat to workers and to the general public. Even extremely hazardous chemicals or waste, however, need not unnecessarily endanger human health if they are handled properly. All employees need to be informed about the hazardous chemicals they work with and how to protect themselves. Employees must read and understand all material safety and data sheets (MSDS) prior to utilizing a chemical.

20.2.6 Heavy Equipment Operation

The operation of heavy equipment (i.e., trucks, backhoe, etc.) presents a hazard to personnel during operation and maintenance procedures. All O&M personnel should be trained as to the proper inspection and operating procedures for all heavy equipment they are expected to utilize. Personnel should also demonstrate continued proficiency by successfully undergoing any additional periodic training that may be required to inspect and operate any necessary heavy equipment.

20.2.7 Electrical Hazards

All machines and equipment that require electricity to operate (i.e., pumps, blowers, screens, etc.) present an electrical shock hazard. Electrical hazards can be prevented by making sure the electrical source is disconnected, locked-out, and/or tagged (see **Appendix C**) prior to performing O&M on the equipment. Before working on any piece of electrical equipment, make sure the main switch at the control panel is in the OFF position. Locking-out and/or tagging the equipment should be done to ensure that the machine or equipment is stopped and isolated from all potentially hazardous energy sources before employees perform any servicing or maintenance where the unexpected energization or startup of the machine or equipment, or release of stored energy, could cause injury.

20.2.8 Drowning

Several processes and facilities at the Sandpoint WWTP pose a drowning hazard. Personnel or visitors to the facility must use extreme caution around the headworks, aeration basin, clarifiers, and Chlorine Contact Chamber. Guardrails are provided for protection. Venturing beyond the guardrail or in areas not designated for traffic could lead to a person falling into hazardous areas and potentially drowning. Furthermore, aeration basins and digesters present increased drowning hazards as the water in these basins is highly aerated. The high air content reduces the density of the water, making even a highly trained swimmer unable to stay at the surface. Some possible safety precautions might include tethering workers to a solid point so that if they were to fall into one of the basins, they could climb out or be pulled to safety. Other precautions include leaving flotation devices nearby and perhaps having personnel work in pairs when working around the treatment unit.

20.2.9 Housekeeping

A high standard of housekeeping is emphasized at the Sandpoint WWTP because it is the greatest single deterrent to fire, accidents, and disease. Every effort should be made to eliminate fire hazards by using proper containers for wastes, papers, and rags, and by emptying the containers frequently. Clean out deposits in cabinets, ductwork, and piping frequently. Immediately clean up liquid or chemical spills such as oil or water to prevent falls. Thoroughly clean tools after contact with wastewater or sludge to reduce the chance of infection or disease. Maintain all tools and portable equipment in a dedicated location that is out of the way of high traffic areas.

The following actions should be avoided when housekeeping:

- Cleaning on or near equipment that is operating. Normally, equipment must be shut down and locked-out and tagged when cleaning nearby.
- Mixing common cleaning compounds that produce a potentially hazardous compound when combined. Read the instructions on all containers prior to use.
- Using hazardous cleaning chemicals without the proper personal protective equipment.
- Over-reaching.
- Climbing on pipes and other equipment.
- Entering hazardous areas, such as manholes, without adequate training, protection, and assistance.
- Moving or attempting to move objects that are too heavy, or lifting heavy objects incorrectly.
- Hosing down areas where electrical equipment is located.
- Using ladders improperly.

20.3 Personal Protective Equipment

Personal protective equipment should be utilized by all personnel exposed to wastewater or contaminated equipment to reduce the number of injuries, infection, diseases, suffocation, or exposure to other hazards. This may include, but is not limited to:

- Rubber gloves
- Rubber footwear
- Eye protection
- Ear protection

All personnel should be trained in the proper use of and wear appropriate personal protective equipment while engaged in necessary work and related tasks or activities. Management should ensure that all necessary training and personal protective equipment are provided to personnel.

When working with chemical systems, appropriate safety equipment should be coordinated with the chemical manufacturer and any emergency response teams.

The personal protective equipment should be properly fitted and operating. Employees should report all defective equipment to their supervisor and the defective equipment tagged and documented with an explanation of problems or defects. All defective equipment should be inspected by qualified personnel, repaired, and returned to service or recommended for replacement.

20.4 Training

All personnel should be trained in all applicable local, state, and federal safety standards and regulations. This may include:

- Potential safety hazards
- Confined space entry
- First aid and cardiopulmonary resuscitation (CPR)
- Operation of treatment facilities equipment
- Heavy equipment operation
- Use of personal protective equipment
- Accident reporting

20.5 Reporting Accidents

All on-the-job accidents to O&M personnel should be reported to their supervisor or management using the Accident Report Form shown on **Figure 20-1**. All Accident Report Forms should be reviewed and investigated by management and follow-up action taken to prevent further accidents by reducing or eliminating the hazard. Personnel should also report conditions they feel are unsafe or need attention for further evaluation and corrective action, if necessary, by their supervisor or management.

Figure 20-1 – Example Accident Report Form

Name: (First) (Middle) (Last)	Date:
Employee Address: City:	State: Zip Code:
Place of Accident:	Was Place of Accident on Employers Premises? [ ] Yes [ ] No
Date of Accident:	Time of Accident:
Date that Accident was Reported to Employer:	Who Was Injury Reported To?:
Did Accident Result in Lost Time?: [ ] Yes [ ] No	If Yes, Give Date Last Worked:
What was Employee Doing when Accident Occurred? (Describe Briefly):	
How did the Accident Happen? (Describe Fully):	
What Machine, Tool, Substance or Object was Most Closely Connected with the Accident?:	Were the Appropriate Safeguards in Place?: [ ] Yes [ ] No
Where Other People Injured in the Accident?: [ ] Yes [ ] No	If Yes, Who was Involved?:
Describe the Injury or Illness in Detail:	
Did Employee Receive Treatment?: [ ] Yes [ ] No	If Yes, Provide a Brief Description of Treatment:
Name and Address of Physician:	
Name and Address of Hospital:	
Signature of Employer:	Signature of Employee:

20.6 Safety Contact List

Table 20-1 outlines safety contacts and phone numbers that should be posted near telephones and carried by personnel with mobile telephones.

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Fire Department	208-263-3502
Avista Utilities	
Buried/Overhead Power	800-824-9763 ext. 6951
Natural Gas	800-824-9763 ext. 6951
Idaho Department of Environmental Quality	
John Tindall	208-769-1422
Panhandle Health District	208-263-5159
Frontier (telephone)	1-800-483-5000
One Call	811

20.7 Safety Equipment List

Safety equipment such as fire extinguishers, first aid kits, personal protective equipment, etc. is located at the Control Building. Personnel should familiarize themselves with the locations of such items and check the condition and/or supplies available on a continuous basis.

20.8 Additional References

The following documents are suggested for further information on safety issues and mitigation:

- Water Pollution Control Federation Manual of Practice (WPCF MOP) #1 - Safety in Wastewater Works
- WPCF MOP #18 - Operation of Wastewater Treatment Plants
- EPA Manual - Safety in the Design, Operation and Maintenance of Wastewater Treatment Works, Contract No. 68-01 - 0324

Chapter 21

Utilities

Chapter 21 – Utilities

21.1 Utility List

The following list of utilities serves the WWTP. This list should be updated regularly and added to as necessary.

Utility	Company	Phone Number
Telephone	Frontier	800-483-5000
Utility Line Locates	One Call	811
Electric	Avista	208-824-9763 ext. 6951
Gas	Avista	208-824-9763 ext. 6951
Water	City of Sandpoint	208-263-3407

Appendices